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MANUAL OF OPERATIVE SURGERY.

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BY

J

W. ARBUTHNOT LANE, M.B., M.S., F.R.C.S.,

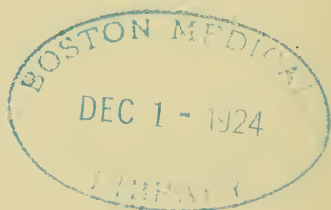
*Senior Demonstrator of Anatomy, Guy's Hospital ;
Assistant-Surgeon to the Hospital for Sick Children.*



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PREFACE.

IN using this book, I would advise the reader to avail himself as much as possible of the illustrations in the anatomical text books, and by this means to make himself familiar with the exact relations of the structures described in the various operations. I have refrained from introducing a number of anatomical plates for the reason that the reader has already in Quain's and Gray's anatomical text books drawings that cannot be easily excelled; also because I think he will find it more convenient to have the illustrations in a separate book, rather than to have to refer continually to a drawing on a preceding page. I have made outline copies of several of the plates in Braune's large atlas, which I hope will prove useful in illustrating the descriptions of the structures cut through in the amputations and ligatures.

In all the amputations and excisions of the limbs, the operation is supposed to be performed on the right side, so that in describing an operation on the left side, some alteration in the description will be obviously necessary.

I have omitted to give the requisite details as regards anti-septic treatment, as it would necessitate so much repetition.

I have repeated many of the diagrams, several of which represent more than one operation, as I considered that by this repetition, the points in connection with each would be more impressed on the eye than if every diagram represented only one operation.

W. ARBUTHNOT LANE.

14, ST. THOMAS'S STREET, S.E.



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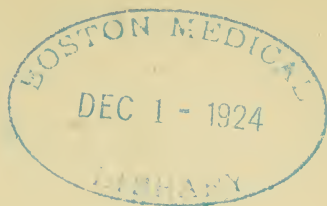
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HANDBOOK OF OPERATIVE SURGERY.

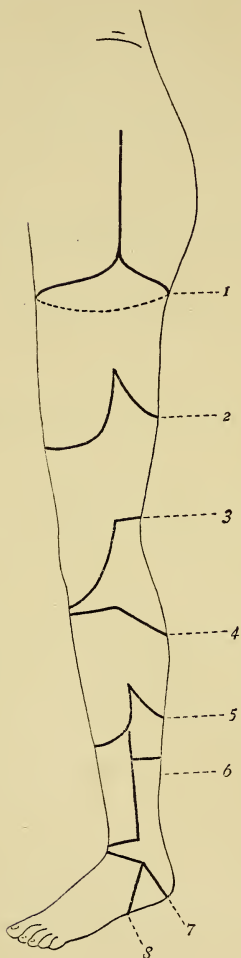
SECTION I.—AMPUTATIONS OF THE LOWER EXTREMITY.

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THAT amputation at the hip-joint which is most satisfactory in its results is

LISTER'S MODIFICATION OF FURNEAUX JORDAN'S OPERATION.

Steps of the Operation.

1. Empty the limb of blood by keeping it in the vertical position for a few minutes. Then surround the extreme upper part of the thigh by a strong elastic band, having previously arranged two or three pieces of bandage beneath the elastic. These are held in the hands of an assistant, who prevents the band from slipping downwards over the flaps during dislocation. It is usual to use an elastic band sufficiently thick to require your full strength to stretch it to double its length. It is, however, more easy to apply a thinner band, in which case it is necessary that it should encircle the thigh twice or thrice. See Fig. 1.
2. The limb being held by an assistant, make a vertical incision about eight inches long in the adult, commencing



half an inch above the posterior superior angle of the great trochanter. You divide in this incision *skin* and *superficial fascia* containing branches of the *external cutaneous nerve*.

3. From the lower extremity of the longitudinal incision make two incisions slightly convex downwards over the front and back of the thigh to a point on its inner aspect two inches below the commencement of these incisions, dividing *skin* and *superficial fascia*. In the latter you cut in the anterior flap from within outwards the *internal saphena vein* surrounded by *lymphatics*, and accompanied by cutaneous branches of the *internal cutaneous nerve*, also the two branches of the *middle cutaneous*, and the anterior branch of the *external cutaneous*. In the posterior flap cutaneous branches of the *small sciatic* and branches of the *external cutaneous nerves* are divided.

Fig. 1. Outer side of left leg.

1 indicates the lines of the incisions in Lister's modification of Furneaux

Jordan's amputation at the hip joint, the dark lines showing those on the outer aspect, and the dotted lines those on the inner aspect of the thigh.

2 indicates the lines of the incisions in Lister's amputation through the thigh.

4. Dissect up the skin and superficial fascia from the deep fascia to the level of or immediately above the lower extremity of the vertical incision. Then by a circular incision divide all the soft structures down to the bone. These are shown in Fig. 2.

In doing this you divide from without inwards in the front of the thigh beneath the fascia lata the *vastus externus*, *rectus femoris*, *sartorius*, *adductor longus*, and *gracilis*. Beneath the rectus the *vastus internus* and *crureus* are divided, and beneath the adductor longus a portion of the *adductor brevis* and *magnus*. The *femoral artery* is divided in the interval between the *sartorius*, *adductor longus*, and *vastus internus*. The *vein* lies behind and a little to the outer side of the artery and the *long saphenous nerve* external to both. On the inner margin of the *vastus externus* is the descending branch of the *external circumflex artery* with its veins, and in the substance of the *vastus internus*, *crureus*, and *vastus externus* are divided the nerves to these muscles. On the anterior surface of the *adductor brevis* the *profunda artery* and *veins* are cut through near the femur, and more internally the superficial branch of the *obturator nerve*. The deep branch of the *obturator nerve* is divided as it lies between the *adductor brevis* and *magnus*. Lying beneath the deep fascia internally are the two branches of the *internal cutaneous nerve* and a branch of the *obturator nerve*.

In the back of the thigh you divide from within outwards the *adductor magnus* at its insertion, behind it the *internal intermuscular septum*, the *semimembranosus* with the *semitendinosus* lying on it, the *biceps* and *external intermus-*

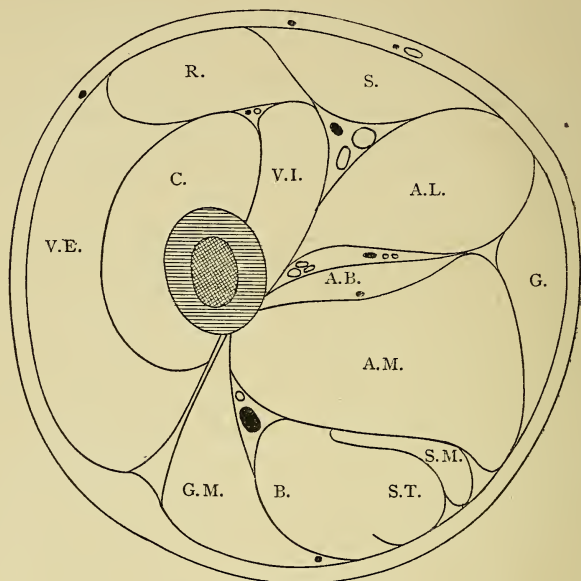


Fig. 2. Transverse section of the thigh at a point about three inches below the lesser trochanter.

As in all the following transverse sections, the muscles are indicated by their initial letters.

The femoral artery, vein, and nerve, are seen lying in the angular interval between the adductor longus, vastus internus, and sartorius; the nerve to the vastus externus and the descending branch of the external circumflex artery between the crureus, rectus, and vastus internus; the profunda vessels between the vastus internus, adductor longus, and adductor brevis; the superficial division of the obturator nerve in front of the adductor brevis, and the deep division behind that muscle; the great sciatic nerve, the sciatic artery, and the comes nervi ischiadici between the gluteus maximus, adductor magnus and biceps; the small sciatic nerve in the back of the thigh beneath the fascia lata.

cular septum, and the lower limit of the *gluteus maximus*. The *great sciatic nerve* with the *comes nervi ischiadici* are divided in front of the biceps, and the *small sciatic nerve* immediately beneath the *fascia lata*. Portions of the *vastus externus* and *crureus* are cut through external to the intermuscular septum.

5. In the line of the vertical incision cut down on the femur, dividing *fascia lata*, aponeurosis of *gluteus maximus*, the *vastus externus*, the *crureus*, and the *bursæ* between the *gluteus maximus*, great trochanter, and *vastus externus*. Transverse branches of the *external circumflex artery* are divided beneath the *vastus externus*.
6. Now keeping close to the bone, dissect the soft structures from it till you have cleared the anterior surface of the capsule of the joint. You divide in so doing the origin of the *vastus externus* from the base of the great trochanter, the insertions of the *gluteus medius* and *minimus*, the origins of the *vastus internus* and *crureus*, the origin of the *iliacus minor* from the front of the capsule of the joint and ascending branches of the *external circumflex artery*.
7. Now raise the soft parts from the back of the bone and joint separating the *vastus externus crureus* and *external intermuscular septum* from the *linea aspera*. Then cut through at their insertions the *pyriformis*, *obturator internus*, and *gemelli*, *quadratus femoris*, *gluteus maximus*, *adductor magnus*, *brevis*, and *longus*, and the *psoas* and *iliacus*. No arteries of any size are divided in raising these flaps. Now cut through the capsule of the joint and the *ligamentum teres* and remove the limb.
8. Bring the edges of the flaps carefully together, and introduce the drainage-tubes into that portion of the wound formed by the vertical incision.

Should a longer stump be shaped, Fig. 3 will give the

relative positions of the structures cut through in the circular section of muscles.

Sometimes it is advisable to separate the periosteum from the femur, in which case a much firmer stump is obtained.

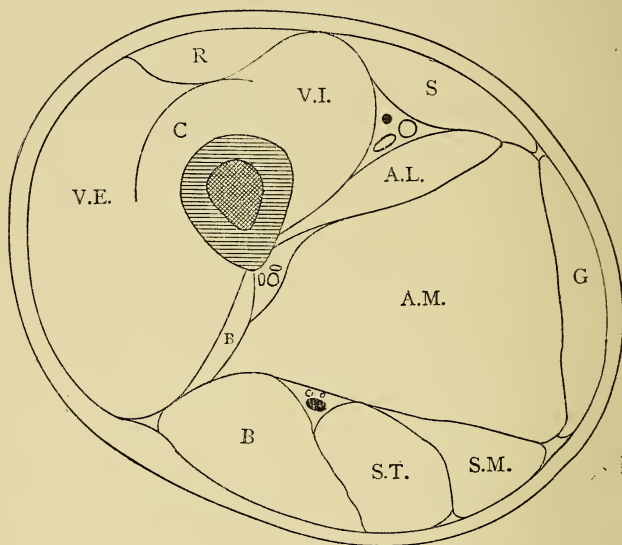


Fig. 3. Transverse section through centre of thigh.

The profunda vessels are seen as they lie between the femur and the adductor magnus.

The great sciatic nerve and the comes nervi ischiadici lie between the biceps, semitendinosus, and the adductor magnus.

The advantages of this operation are that the wound can be kept antiseptic, since it is at some considerable distance from the anus. By this means the danger from shock is enormously diminished. The stump resulting from the operation is much

longer than in the ordinary flap amputation, and should the subperiosteal method be adopted it is still much firmer. On this account an apparatus can be more easily fixed to it.

FURNEAUX JORDAN'S OPERATION.

Steps of the Operation.

1. Apply elastic pressure to control the circulation after emptying the blood-vessels by an Esmarch's bandage, or by holding the limb in the erect position.
2. Make an incision about five or six inches in length along the outer aspect of the femur, commencing just above the trochanter, and proceed to free the capsule of the joint, as in excision. Then divide the capsule and dislodge the head of the femur.
3. Continue the vertical incision down the outer side of the thigh, and rapidly separate the muscles from the shaft of the femur.
4. Replace the femur in its bed, and make a circular incision through the skin and subcutaneous tissue, then retracting the skin make another circular incision through the muscles down to the bone.
5. Twist or ligature all the vessels.
6. Bring the edges of the wound accurately together, and insert the drainage-tubes in the lower and outer angle of the wound.

Since the structures cut through are almost the same as those divided in Lister's modification of this operation, I will not give them again in detail. See Fig. 2 and Fig. 3.

AMPUTATION THROUGH THE HIP JOINT BY ANTERO-POSTERIOR FLAPS.

Steps of the Operation.

1. Empty the vessels of the limb and control the circulation in the manner already described. Define the position of the anterior superior spine, hip joint, and tuber ischii. Stand to the left side of the limb to be removed. The buttocks of the patient are brought well to the edge of the table, and an assistant holds the thigh slightly flexed on the trunk and rotated inwards.
2. Enter the point of a long amputating knife about two inches below the ramus of the pubes and near the tuberosity. Pass the point of the knife in the direction of a point midway between the anterior superior spine and the great trochanter, and you must remember in doing this that the point of the knife must pass immediately over the front of the head and neck of the femur and behind the large vessels and the muscles on which they lie, so that having passed the head the point of the knife will have to be depressed to enable you to bring it out midway between the spine and trochanter.
3. Now cut downwards parallel to the anterior surface of the femur, then turn the blade forwards, and shape a flap between six and eight inches long. See Fig. 4.

In transfixing, the point of the knife passes through skin, superficial fascia, deep fascia, the gracilis, the adductor magnus, the adductor brevis, the inner margin of the pectineus, the psoas, iliacus and iliacus minor, with the bursa beneath these muscles and a portion of the front of the capsule of the joint. The point then passes through

a deep process of fascia lata, the anterior margins of the gluteus minimus and medius, the tensor vaginæ femoris, fascia lata, superficial fascia, and skin.

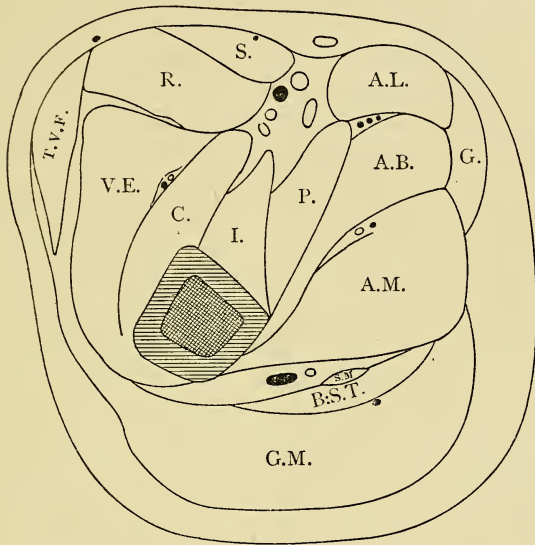


Fig. 4. Section through the thigh immediately below the trochanter minor.

The great sciatic nerve and the sciatic artery lie on the posterior aspect of the adductor magnus; the deep division of the obturator nerve on the anterior surface of the adductor magnus; the superficial division of the obturator nerve between the adductor longus and brevis; the nerve to the vastus externus with the descending branch of the external circumflex artery between the vastus externus and crureus; the femoral artery and vein, the anterior crural nerve, the profunda artery and vein in the space between the adductor longus, pectineus, iliacus, crureus, rectus, and sartorius; the small sciatic nerve between the semitendinosus and the gluteus maximus.

In cutting the flap you divide further portions of the muscles already enumerated, and besides these the adduc-

tor longus, the rectus, the vastus externus, internus, the crureus, and the sartorius. See Fig. 2.

The femoral artery is divided where it lies beneath the sartorius, and between the adductor longus and vastus internus with its vein behind it.

The profunda artery with its vein is divided as it lies on the iliacus and psoas or pectineus, its internal circumflex branch being cut through as it passes back between the psoas and pectineus. The three divisions of the external circumflex are divided separately: the upper as it passes over the neck of the femur, the middle as it passes beneath the vastus externus, and the descending branch as it lies on the inner margin of the vastus externus. You cut through the long saphenous nerve and the nerve to vastus internus as they lie external to the femoral artery, the nerve to the vastus externus with the descending branch of the external circumflex artery, the internal cutaneous nerve as it lies superficial to the femoral artery, the superficial branches of the obturator nerve on the adductor brevis, and the deep branches beneath it.

You cut through in the superficial fascia from without inwards the external cutaneous nerve, the two branches of the middle cutaneous, the internal saphena vein accompanied by its lymphatics, the upper cutaneous branch of the internal cutaneous nerve, the ilio-inguinal nerve, and branches of the inferior pudendal nerve.

The large vessels are now to be twisted or ligatured.

3. An assistant retracts the anterior flap, while another abducts the thigh, rotates it outwards, and so extends very forcibly the hip joint. Cut through the front of the capsule, allowing the head to be forced forwards out of the acetabulum, divide the ligamentum teres, and then the posterior portion of the capsule.

4. The assistant now draws the head of the femur and the trochanter forwards, rotating the femur inwards at the same time. You now cut downwards and backwards, forming a posterior flap about four inches in length. The length of this flap varies with the length of the anterior one, and should be much shorter than it. In cutting this flap you divide the remainder of the tensor vaginae femoris, the gluteus medius and minimus; superficial to them the gluteus maximus; the adductor magnus, and any portion of the adductor brevis which is not contained in the anterior flap; behind the neck of the femur the obturator externus, obturator internus with the gemelli, and above them the pyriformis; the quadratus femoris, and superficial to it the three hamstring muscles. You cut the great sciatic nerve and the comes nervi ischiadici as they lie behind the adductor magnus; beside it the small sciatic nerve and its branches with the sciatic artery and its branches; branches of the obturator artery with the tendon of the obturator externus; branches of the gluteal artery and superior gluteal nerve between the gluteus medius and minimus; and branches of the obturator nerve to the hip joint and to the adductor magnus.

Outside these you cut deep fascia and superficial fascia containing cutaneous branches of the small sciatic nerve.

5. Ligature or twist any vessels, and bring the edges of the flaps together with sutures, and introduce drainage tubes.

AMPUTATION THROUGH THE HIP JOINT BY LATERAL FLAPS.

Steps of the Operation.

1. The patient being in the same position as in the last operation, and the circulation controlled, define carefully the

position of the femoral vessels, great trochanter, and tuberosity of the ischium. Make a semicircular incision, starting from the tuberosity of the ischium and passing downwards and forwards to a point one hand's-breadth below the great trochanter, thence passing gradually upwards and forwards to the centre of the groin on the outer side of the femoral vessels.

2. Cutting inwards, reflect this flap upwards to the level of the upper border of the great trochanter. You now open the joint and disarticulate, an assistant forcibly adducting the limb to facilitate this step.
3. Now make the inner flap by transfixing the thigh on the inner side, inserting the knife in the anterior wound, passing it backwards close to the inner side of the neck of the femur, and bringing it out near the tuberosity of the ischium where the external incision was commenced, and then cutting out through the soft parts, including all the adductors, &c.

I have taken the account of this operation from Mr. Bryant's "Surgery." He proposes to ligature the common femoral before the second flap is made, should there be much fear of loss of blood.

The incision being vertical, the drainage is more satisfactory than in the amputation by antero-posterior flaps.

AMPUTATION THROUGH CENTRE OF THIGH.

LISTER'S FLAP METHOD.

Steps of the Operation.

1. The upper limits of the flaps must be placed about two inches below the point at which you intend to divide the femur. See Fig. 1.

Make two vertical lateral incisions along the inner and outer aspects of the thigh, each equal in length to two-thirds of the diameter of the limb. Join their lower extremities by a transverse incision across the front of the thigh, sloping it obliquely upwards at its extremities, so that the angles of the flap may be rounded. This incision extends through *skin* and *superficial fascia*, containing the *internal saphenous vein*, *lymphatics*, and upper branches of the *internal cutaneous nerve*, the anterior branch of the *internal cutaneous*, the two branches of the *middle cutaneous*, and the anterior branch of the *external cutaneous nerves*.

2. Make a skin-flap from the posterior aspect of the thigh by cutting it at an angle of forty-five degrees to the axis of the limb. Reflect it at once.

You divide *skin* and *superficial fascia*, containing the internal branch of the *internal cutaneous*, branches of the *obturator*, branches of the *small sciatic*, and branches of the *external cutaneous nerves*.

3. Raise the anterior flap, containing a moderate amount of muscle, cutting it from without inwards. Reflect well both flaps. Cut by a circular incision down to the femur through the muscles surrounding it, so as to expose the bone about two inches above the angle of union of the flaps. See Fig. 5, and Fig. 6.

In raising the anterior flap you divide *deep fascia*, portions of *adductor magnus* and *longus*, *gracilis*, *sartorius*, *vastus internus*, *crureus*, *rectus*, *vastus externus*, with the *femoral artery*, *vein*, and *internal saphenous nerve* in Hunter's canal, branches of the *external circumflex artery* along the inner aspect of the *vastus externus*, with the nerve to that muscle, and branches of the nerve to the *vastus internus* in its substance. In the circular incision further portions of the same muscles are di-

vided. On the back of the thigh you divide *deep fascia*, and from without inwards the *vastus externus*, the *crureus*, the *external intermuscular septum*, the two heads of the

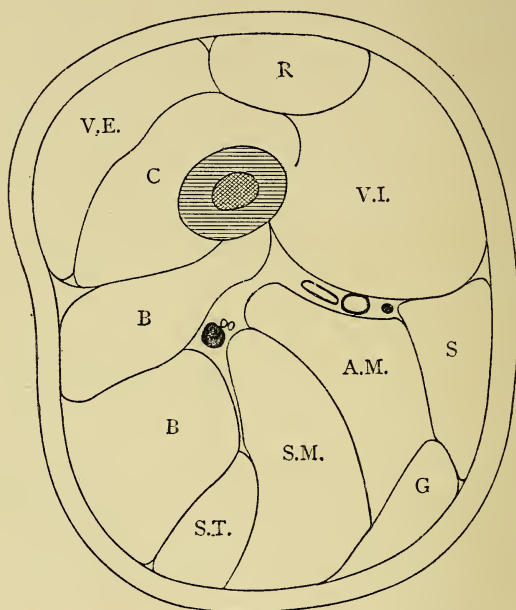


Fig. 5 is a transverse section through the lower third of the thigh, about three inches above the patella.

The femoral artery, vein, and the internal saphenous nerve are seen as they lie between the *vastus internus*, *adductor longus*, and *sartorius* in the lowest part of *Hunter's canal*.

The great sciatic nerve and the *comes nervi ischiadici* are seen to lie between the two heads of the *biceps* and the *semimembranosus* muscles.

biceps, the *semitendinosus*, the *semimembranosus*, and more anteriorly the *internal intermuscular septum* and further portions of the *adductor magnus*, and *adductor longus gracilis*.

Lying between the adductor muscles the *profunda artery* and *vein* are cut, and under cover of the semitendinosus and biceps the *great sciatic nerve* and the *comes nervi ischiadici* are divided. The *small sciatic nerve* is divided beneath the deep fascia posteriorly, and in the adductor magnus branches of the *obturator nerve* to the knee joint.

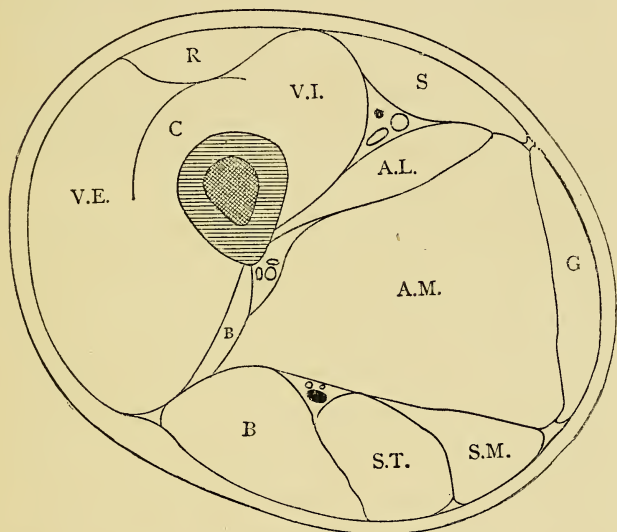


Fig. 6. Section through middle of thigh.

AMPUTATION THROUGH THE THIGH.

CIRCULAR METHOD.

Steps of the Operation.

1. Make a circular incision through the skin and superficial fascia about three or four inches below the point at which you intend to saw through bone. (The point in this de-

scription will be an inch above the centre of the femur.) In so doing you divide skin and superficial fascia, which contains in front branches of the external cutaneous, two divisions of the middle cutaneous, anterior and internal divisions of the internal cutaneous nerves, and on the back of the thigh branches of the small sciatic nerve. The internal saphena vein and lymphatics are also cut through, and occasionally a cutaneous branch of the obturator nerve on the inner aspect of the thigh.

2. Turn the skin and superficial back from the deep fascia for about two inches. An assistant retracts this circular flap. Make a circular incision through the soft structures down to the bone. See Fig. 6.

You divide deep fascia, which encircles the thigh, and beneath it on the front of the thigh the vastus externus, rectus, vastus internus and crureus, sartorius and portions of the gracilis, adductor longus and magnus; on the back of the thigh the vastus externus, the crureus, external intermuscular septum, the two heads of the biceps, the semitendinosus with the tendon of the semimembranosus lying internal to it. More deeply still the adductor magnus and longus muscles are cut through, the gracilis internal to both, the internal intermuscular septum behind the adductor magnus, and in front of the adductor longus an aponeurotic band stretching from the anterior surface of this muscle to the inner aspect of the vastus internus, and sheathing in the structures contained in Hunter's canal. The femoral artery is divided in Hunter's canal, with the vein which lies posterior and external to it, and the long saphenous nerve which lies external to both.

In the adductor magnus is divided the nerve to the knee joint from the deep division of the obturator.

Behind the adductor longus, near the linea aspera, the

terminations of the profunda artery and vein are cut through. The descending branch of the external circumflex artery, with branches of the nerve to the vastus externus, are divided at the inner aspect of that muscle.

The great sciatic nerve with the comes nervi ischiadici are divided on the posterior surface of the adductor magnus, and the small sciatic nerve is cut through as it lies superficial to the hamstring muscles, and beneath the deep fascia.

3. An assistant firmly retracts the skin and muscle while you separate the soft structures from the femur for an inch or more of its length above the level of the circular incision through the muscles. Having done this, you saw through the bone at this point. The divided bone is now seen to form the apex of a cone, whose sides are formed by the divided muscle, subcutaneous tissues, and skin. In clearing the bone you separate the origins or insertions of several of the deeper muscles, namely, the vasti and crureus, the adductor magnus and longus, the short head of the biceps, with the internal and external intermuscular septa. A very satisfactory stump results from this form of amputation. Should the amputation be made through the lower third of the thigh, the structures cut through can be seen in Fig. 5, in their relative positions to one another.

AMPUTATION AT THE KNEE BY CARDEN'S METHOD.

Steps of the Operation.

1. The knee being kept semiflexed by an assistant, stand to the right of the limb. Grasp the lower part of the thigh, so that the tip of the middle finger indicates the position of the tubercle for the insertion of the adductor magnus,

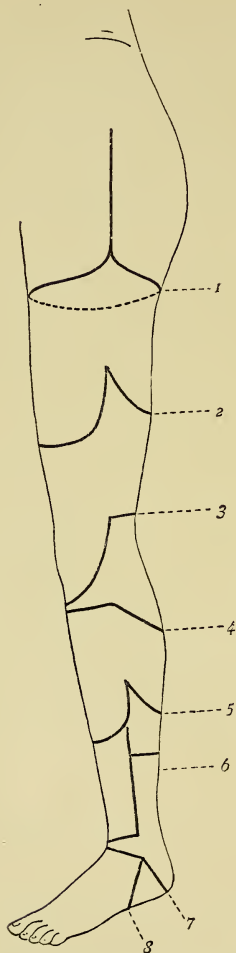


Fig. 7 is the outer aspect of the left leg and thigh.

3 indicates the incisions in Carden's amputation, and 4 the incisions in Lister's modification of Carden's operation.

and the extremity of the thumb is placed on an opposite point which is in the same vertical and horizontal plane as the adductor tubercle. See Fig. 7 and Fig. 8.

2. Join these two points by an incision which is convex downwards, the limit of its convexity approaching the level of the tubercle of the tibia. You cut through *skin* and *superficial fascia*, containing from within outwards the anterior and internal branches of the *internal cutaneous*, the *cutaneous patellæ*, the terminal branches of the two divisions of the *middle cutaneous* and the *external cutaneous nerves*, and, on the inner side, the *long saphenous vein* with its accompanying *lymphatics*. Branches of the *anastomotica magna* and of the *articular arteries* are divided in the superficial fascia.
3. Reflect this flap from the anterior surface of the patella, and, on reaching its upper margin, divide the muscles and

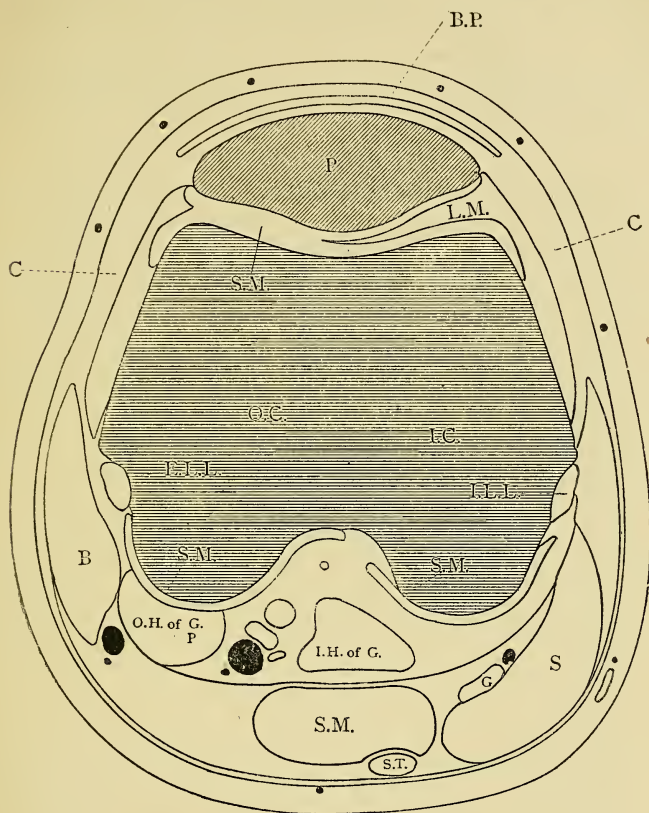


Fig. 8 is a transverse section through the condyles of the femur.

B.P. indicates the position of the Bursa patellæ.

C.	"	"	Capsule.
L.M.	"	"	Ligamentum mucosum.
S.M.	"	"	Synovial membrane.
E.L.L.	"	"	External lateral ligament.
I.L.L.	"	"	Internal lateral ligament.

The popliteal artery, vein, and internal popliteal nerve are seen lying be-

tween the inner head of the gastrocnemius, the outer head of the gastrocnemius and plantaris muscle. The external popliteal nerve lies behind the biceps.

The internal saphenous nerve lies with the tendon of the gracilis outside the sartorius, and the internal saphena vein inside that muscle in the superficial fascia.

deep fascia and reflect them from the femur to the level of the adductor tubercle. (Or the patella with the ligamentum patellæ may be also reflected in the flap, and subsequently dissected out of it.) In doing this you open the bursa over the lower half of the patella, you divide deep fascia above the patella, the quadriceps tendon and muscle, the subjacent synovial membrane of the joint, the external branch of the anastomotica magna, branches of the descending division of the external circumflex, superior internal and external articular arteries, and of nerves to the vastus externus and internus in the substance of these muscles.

4. Now enter the point of the knife with its edge directed backwards at the point you first entered it, pass it behind the femur, and make it emerge through the outer angle of the anterior incision. Cut directly backwards through the soft structures in the back of thigh. In doing this you divide outside the external condyle, the biceps with its aponeurotic insertion into the fascia lata, and, on the inner and posterior part, the sartorius, the gracilis, and lying external to it the semimembranosus with the tendon of the semitendinosus lying on it posteriorly. The two heads of the gastrocnemius and the plantaris are also cut through.

The popliteal artery and the branch of the obturator nerve to the knee joint are divided on the back of the femur, and the popliteal vein lying posterior and a little external to it. Still more posteriorly and externally is divided the internal popliteal nerve with its branches to the skin, muscles, and

joint. The *external saphena vein* may be divided as it enters the popliteal, and the *internal* with its *lymphatics* in the superficial fascia at the lower and inner portion of this incision. The *external popliteal nerve* with the *communicans peronei* and *articular branches* are divided behind and internal to the posterior margin of the biceps tendon. The *internal saphenous nerve* and the superficial branch of the *anastomotica magna artery* are divided at the upper border of the gracilis. Just beneath the *deep fascia*, in the middle line, the terminal branch of the *small sciatic nerve* is divided, and in the *superficial fascia* small branches of the *small sciatic*, *internal*, and *external cutaneous nerves*.

5. Now clear the femur at the level of the adductor tubercle by a circular incision, dividing the *synovial membrane* covering its anterior surface, branches of the *articular arteries* and of the *anastomotica magna*, and the *periosteum*. Saw through the bases of the condyles at this level transversely to the axis of the limb.

Some surgeons remove the articular surface of the patella, which they leave in the anterior flap, and oppose its cut surface to that of the femur, this modification being called Gritti's operation.

LISTER'S MODIFICATION OF CARDEN'S OPERATION.

Steps of the Operation.

1. Cut transversely across the front of the leg at the level of the tuberosity of the tibia, from the inner margin of the tibia to a corresponding point on the outer aspect of the leg, dividing *skin*, *superficial fascia*, and structures contained in it. See Fig. 7 and Fig. 8.
2. Join the extremities of this incision by another, which will

form an angle of forty-five degrees with the axis of the limb. This incision is also through *skin, superficial fascia,* and contained structures.

3. Dissect up the posterior skin-flap and the circle of skin and subcutaneous tissues to the level of the lower margin of the condyles.
4. The assistant then bends the knee to clear the upper margin of the patella. Make a circular incision through the structures about the joint, dividing at the same time the ligaments of the joint. Saw through the bone transversely to the axis of the limb.

These structures have been already described in detail.

AMPUTATION THROUGH KNEE JOINT.—POSTERIOR FLAP.

Steps of the Operation.

1. An assistant holds the leg in an extended position. Make a semilunar anterior flap commencing at the lower and back of the internal condyle, passing just below the patella, and ending at the lower and back part of the external condyle. See Fig. 9. In doing this you divide *skin* and *superficial fascia*, containing from within outwards branches of the *cutaneous patellæ*, anterior and internal branches of the *internal cutaneous*, the *middle* and *external cutaneous nerves*, and branches of the *articular* and *anastomotica magna arteries*.
2. The assistant flexes the leg, and you cut through the joint in the direction of the incisions, dividing *deep fascia*, *ligamentum patellæ*, *capsule*, *ligamenta alaria* and *mucosum*, the *internal lateral* and *two external lateral ligaments* of the knee joint, the *synovial membrane*, the *crucial ligaments*, and the

popliteus and *biceps* tendons. The *inferior external articular artery* and *nerve* are divided as they run with the tendon of the *popliteus*.

3. The assistant holds the tibia and fibula firmly, displacing their upper extremities a little forwards. With the edge of the knife directed downwards, cut a long posterior flap from within outwards and above downwards. This flap should be about four or five inches long.

In clearing the margin of the tibia to introduce the blade of the knife flat along its posterior surface, you divide the *posterior ligament* of the joint, the *semimembranosus* internally at its insertion into the head of the tibia, and any of the *biceps* not already completely divided. You then divide the fibular origin of the *soleus*, the *plantaris*, and both heads of the *gastrocnemius*. The *sartorius*, *gracilis*, and *semitendinosus* will be divided from before backwards as they lie in the inner aspect of this flap. The *popliteal artery* is divided near its termination, and its *inferior internal and external articular and muscular branches*. The *vein* is divided on its inner aspect, and the *internal pop-*

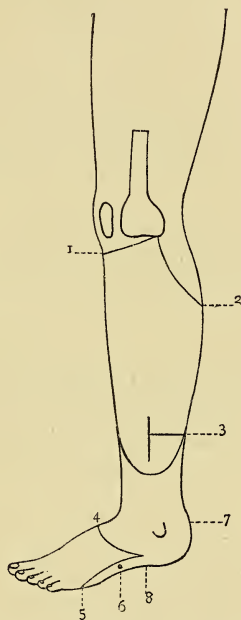


Fig. 9 is a diagram of the outer aspect of the left leg.

The lower end of the femur, and the patella are shown; also the external malleolus, which is indicated by No. 7.

1 and 2 show the incisions in amputation through the knee joint by a large posterior flap.

1 and 2 show the incisions in amputation through the knee joint by a large posterior flap.

liteal nerve internal and superficial to both. The *external popliteal nerve* is divided as it lies on the posterior and inner aspect of the biceps tendon. Superficial to these structures are divided *deep* and *superficial fasciæ*, containing the *communicans fibularis* and *tibialis*, and the termination of the *small sciatic nerve* accompanying the *external saphena vein*. The *internal saphenous vein* and nerve and the superficial branch of the *anastomotica magna* are divided in the inner portion of this flap.

ANTERIOR FLAP AMPUTATION THROUGH THE KNEE JOINT.

Steps of the Operation.

1. The leg is held extended by an assistant. Make a long anterior flap whose convexity shall extend to a point about one and a half inches below the tubercle on the tibia, and which shall commence and end at the lower and back part of each condyle. In this incision you only divide *skin* and *superficial fascia* with structures already enumerated.
2. Make a very short posterior flap, dividing *skin* and *superficial fascia*, with the *external saphenous vein*, *lymphatics*, the termination of the *small sciatic nerve*, the *internal saphenous vein*, and accompanying *lymphatics*, and branches of the *internal and external cutaneous nerves*.
2. Dissect up the skin and superficial fascia to the level of the lower margin of the condyles. The knee is now slightly flexed, and the joint is cut through, with the soft parts surrounding it. These last have been already enumerated in the preceding operation.

Some operators prefer to remove the patella, in which case the circular incision is made at its upper limit.

AMPUTATION THROUGH THE KNEE BY LATERAL FLAPS.

Steps of the Operation.

1. Make two convex lateral incisions, commencing at the anterior margin of the tibia about an inch below the tubercle, and reaching the median line posteriorly at a point on a level with their commencement. The inner flap should be a little larger than the outer. From the angle of junction of the flaps on the posterior aspect of the leg make a vertical median incision to the level of the knee joint. See Fig. 10.
2. Reflect the skin and subcutaneous tissue to the lower margin of the patella. Cut through the ligamentum patellæ and the other ligaments of the joint, and divide the remaining structures by a circular incision at this level.

AMPUTATION OF THE LEG THROUGH THE CALF.

LISTER'S METHOD.

Steps of the Operation.

1. Measure the diameter of the limb. Make a longitudinal incision equal in length to half this diameter along the inner aspect of the leg from a point an inch below the intended division of bone, which in this description is an inch above the centre of the leg. See Fig. 7 and Fig. 11.
2. Make another incision on the outer aspect of the leg directly over the fibula, commencing an inch higher up

than the one on the inner aspect of the leg, and ending in the same horizontal level as the last.

3. Join the extremities of these vertical incisions by a trans-

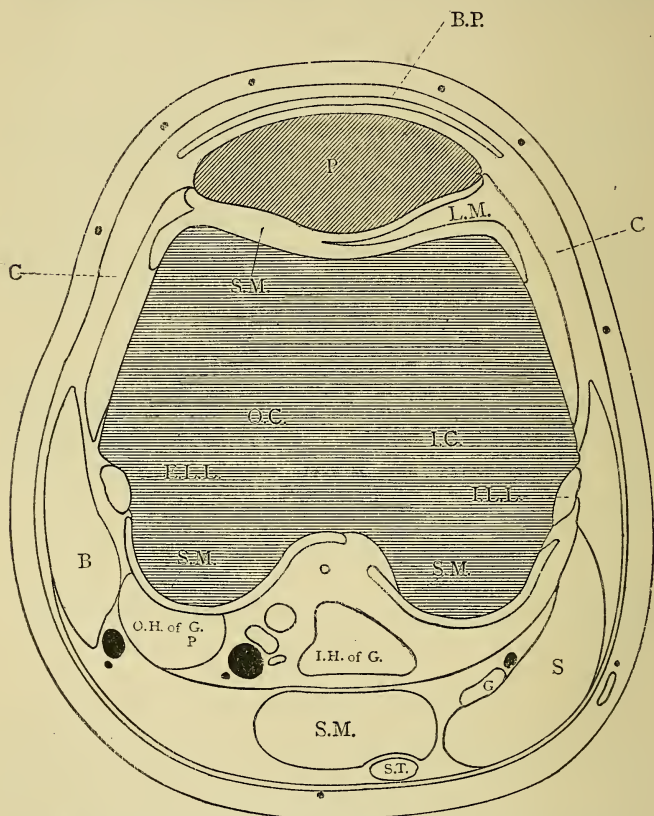


Fig. 10 is a transverse section through the condyles of the femur.

verse incision crossing the front of the leg, taking care that each of the posterior extremities of this incision

slopes upwards so as to round the angles of this flap. These incisions are carried through *skin* and *superficial fascia*, and in this fascia the *internal saphenous vein*, *lymphatics*, and *nerve*, with branches of the *external saphenous*

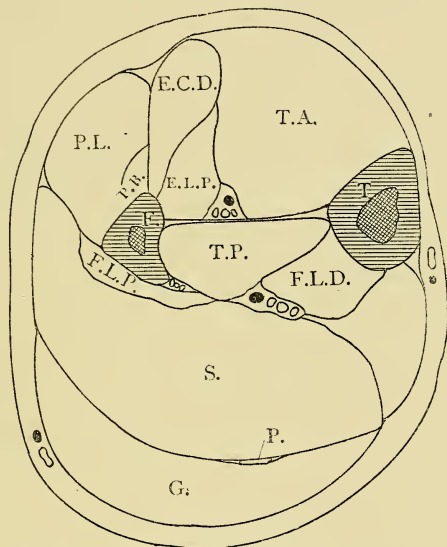


Fig. 11. Section through middle of right leg.

The anterior tibial vessels and nerve are seen lying on the interosseous membrane between the tibialis anticus and the extensor longus pollicis; the posterior tibial vessels and nerve between the tibialis posticus, flexor longus digitorum, and the soleus; the peroneal vessels between the flexor longus pollicis, tibialis posticus, and fibula. The internal and external saphenous veins and nerves are seen in the inner and outer aspects of the leg.

vein and nerve, are divided. The *musculo-cutaneous nerve* is divided as it emerges from the deep fascia of the leg.

4. Connect the upper extremities of the inner vertical incision with the outer incision, at the same level, by an incision

which crosses the back of the leg at an angle of forty-five degrees to the vertical, dividing *skin* and *superficial fascia*, containing the *external saphenous vein*, *nerve*, and *lymphatics*, and branches of the *internal saphenous vein*, *nerve* and *lymphatics* and *small sciatic nerve*.

5. Raise the anterior flap to the level of the upper end of the inner incision, cutting through all the soft structures down to the bone, carefully avoiding the anterior tibial vessels, which you separate from the interosseous membrane with the tip of the finger. In doing this you divide *deep fascia* with the *intermuscular septa*, the *tibialis anticus*, *extensor proprius pollicis*, *extensor communis digitorum*, and the *peroneus tertius*, should it extend high up the leg. The *peroneus longus* and *brevis* with a portion of the *soleus* will also be divided in the outer vertical incision. The *anterior tibial vessels* and *nerve* will be divided between the *tibialis anticus* and *extensor proprius pollicis*. In reflecting this flap these muscles are all partly removed from their bony origins.
6. Reflect the skin and superficial fascia forming the posterior flap to the same level, and divide the structures on the back of the leg down to the bone.

You divide *deep fascia*, *gastrocnemius*, the *plantaris*, any portion of the *peroneus longus* or *brevis* not divided in cutting the anterior flap, the *soleus*, a layer of *deep fascia*, and beneath it the *flexor longus digitorum*, *tibialis posticus*, and *flexor longus pollicis*. The *posterior tibial vessels* and *nerve* are cut through as they lie on the *tibialis posticus*, and external to them, and under cover of the *flexor longus pollicis*, the *peroneal artery* and the *nerve* to the *flexor longus pollicis*.

7. Reflect the soft parts from the bone to the level of the upper limit of the external incision; that is, for an inch higher up. Clear the bone, and divide it with the interosseous membrane at this level.

By means of these incisions the heavy mass of sural muscles is excluded from the posterior flap.

AMPUTATION OF THE LEG BY TEALE'S METHOD.

Steps of the Operation.

The only part of the leg where this amputation is now performed is in the lower portion of the calf. As will be seen from the description of the operation, it cannot well be applied to the leg where its circumference is great. See Fig. 11 and Fig. 12.

1. Measure the circumference of the leg at the lower limit of the calf. Divide this circumference into two equal anterior and posterior portions, taking care that the points of division are in the same horizontal planes. From these points mark two vertical lines, each equal to the semi-circumference of the limb, and join the lower extremities of these vertical incisions by a transverse mark crossing the front of the leg.
2. At the junction of the lower three-fourths with the upper fourth of the vertical lines mark out a transverse incision, which crosses the posterior aspect of the leg.
3. Make vertical and transverse incisions along the lines which mark out the square anterior flap, dividing all the soft part down to the bone, and reflect this flap to the upper limit of the vertical incision. You divide *skin* and *superficial fascia*, containing the *internal saphenous vein*, *nerve*, and *lymphatics*, the two divisions of the *musculo-cutaneous*, and branches of the *external saphenous nerves*, *anterior annular ligament* and *deep fascia*, the *tibialis anticus*, *anterior tibial artery*, *veins*, and *nerve*, their *muscular branches*, the *extensor longus pollicis*, *extensor communis digitorum*, the *peroneus*

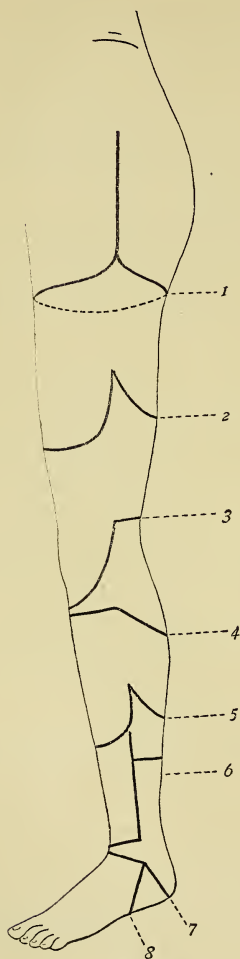


Fig. 12.

- 6 indicates the lines of the incisions in Teale's amputation.
 7 the lines of incisions in Syme's or Pirogoff's amputations, and
 8, the lower oblique incision in the modified form of Pirogoff's amputation.

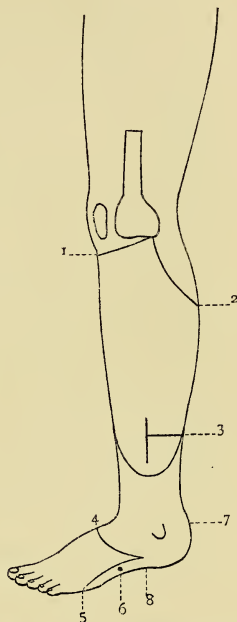
tertius, and the *anterior peroneal artery and veins* emerging from beneath it.

In the outer vertical incision the knife will pass obliquely through the *peroneus brevis* and *longus* muscles. In raising the anterior flap these muscles must be raised from the bones, the anterior tibial vessels and nerve being separated carefully from the interosseous membrane with the tip of the finger.

4. Make an incision down to bone along the transverse marking across the back of the leg, and raise this flap to the same level as the anterior. In doing this you divide *skin*, *superficial fascia* with the *external saphena vein*, *lymphatics*, and *nerve*, and branches of the *internal saphenous nerve*, *deep fascia*, the tendon of the *gastrocnemius*, beneath it that of the *plantaris*, and the aponeurotic posterior aspect of the *soleus* blending with the anterior aspect of the *gastrocnemius*, a layer of *deep*

fascia beneath these muscles, and outside them those portions of the *peroneus brevis* and *peroneus longus* not contained in the anterior flap. Beneath the deep layer of deep fascia the *flexor longus digitorum*, *tibialis posticus*, and *flexor longus pollicis* are raised in the flap, and the posterior tibial artery and veins, as they lie superficial to the flexor longus digitorum, the nerve lying superficial and external to them. The *peroneal artery* is divided as it lies beneath the flexor longus pollicis.

5. Saw through the bones at the upper limit of reflection of the flaps.
6. Bend the long anterior flap on itself and suture its angles to those of the posterior flaps. See Fig. 13.



SYME'S AMPUTATION.

Fig. 13. Outer aspect of left leg.

In Syme's Amputation, the foot is removed at the ankle joint, together with the lower extremities of the tibia and fibula, just above the bases of the malleoli.

3 shows the stump left after the flaps have been brought together in Teale's amputation through the lower part of the calf.

Steps of the Operation.

1. Control the blood supply by an elastic tourniquet above knee.

2. The foot being held at right angles to the leg, grasp the back of the heel with the left hand, so that the tip of the index finger rests on the extremity of the outer malleolus, and the tip of the thumb indicates a point exactly opposite to it. This will be seen to be considerably below and behind the lower extremity of the inner malleolus. See Fig. 12.
3. Using a short, strong-bladed knife, make an incision across the sole of the foot joining these two points, cutting at once down to bone. This incision may be vertical, but should the heel be very prominent, it is advisable to make it slope a little backwards towards the heel. Now extend the foot and join the extremities of this incision by one running straight across the front of the ankle.

In making the second incision you divide—*Superficial fascia*, containing the *internal saphenous vein* with *lymphatics* in front of the inner ankle, accompanying them the *internal saphenous nerve*, and outside it the two branches of the *musculo-cutaneous nerve* and branches of the *external saphenous nerve*. Branches of the *internal calcanean*, the *internal malleolar*, *external malleolar*, and *anterior peroneal arteries* are also cut.

Beneath the superficial fascia you divide in the same order *internal annular ligament* with the tendons of the *tibialis posticus* and *flexor longus digitorum* surrounded by synovial sheaths, the *anterior annular ligament* covering the tendons of the *tibialis anticus*, *extensor longus pollicis*, *extensor longus digitorum*, and *peroneus tertius*. Beneath the last tendon is seen a part of the fleshy origin of the *extensor brevis digitorum*. The termination of the *anterior tibial artery* with its *venæ comites* is divided between the tendons of the extensor of the great toe and those of the smaller toes, and lying to its

inner side is the termination of the *anterior tibial nerve*.

In making the first incision you cut through *superficial fascia*, which is very thick in the sole of the foot, and consists of fibrous septa containing in its meshes nodules of fat. In the superficial fascia you see the cut ends of the *calcaneo plantar cutaneous* branch of the posterior tibial nerve below the inner malleolus, the *external saphenous nerve* and its branches below the outer malleolus, and near it the *external saphena vein* accompanied by *lymphatics*.

Branches of the *internal calcanean artery* are divided on the inner aspect of the heel, and on the outer branches of the *anterior* and *posterior peroneal arteries*. Beneath the superficial fascia the *internal annular ligament*, the *inner*, *middle*, and *outer* divisions of the *plantar fascia* and the *external annular ligament* are divided, and beneath these structures, the *abductor pollicis* covering the tendon of the *flexor longus pollicis* and the fleshy origin of the *flexor accessorius*. Above the tendon of the flexor of the great toe the *posterior tibial artery* is divided with its *venæ comites*, and below the artery the *posterior tibial nerve*. In some subjects, instead of single trunks, the *internal* and *external plantar arteries* and *nerves* would be divided. This depends a good deal on the direction of this incision.

Outside these are divided the *flexor brevis digitorum* and the *abductor minimi digiti*; also the tendons of the *peroneus longus* and *brevis* and the middle fasciculus of the *external lateral ligament*. These two tendons are surrounded by *synovial membranes*.

4. Now dissect the posterior flap from the under surface of the os calcis till the heel is turned, keeping the edge of the

knife close to the bone. You divide in so doing the attachment to it of the *internal annular ligament*, the three divisions of the *plantar fascia*, the *external annular ligament*, the *abductor pollicis*, *flexor accessorius*, *flexor brevis digitorum*, and *abductor minimi digiti*.

5. Separate the tibia, fibula, and astragalus by cutting through the *anterior ligament* of the ankle joint, the *internal lateral ligament* immediately below the internal malleolus, the *anterior division* of the *external lateral ligament*, and later the *posterior division*, the *middle division* having been already cut through. Clear the upper surface of the os calcis from the surrounding fat, dividing further portions of the *internal* and *external annular ligaments*. Finally cut through the *tendo Achilles* at its insertion, at the same time opening the *bursa* between it and the bone.
6. Now separate the soft structures from the tibia and fibula to a point half an inch above the margin of the articular surface on the under aspect of the tibia, dividing in so doing that portion of the *deep fascia* and *annular ligaments* which bind these parts down to the bone. Retract them, and saw transversely through the tibia and fibula at this level.
7. The edges of the flaps must now be brought together and drainage tubes inserted.

PIROGOFF'S AMPUTATION.

In Pirogoff's Amputation the steps of the operation are similar to those in Syme's operation, except that the portion of the os calcis behind the posterior margin of the astragalus is left in the flap, and is adjusted to the cut surface of the tibia and fibula. See Fig. 12.

Some surgeons prefer to cut the surface of the tibia and

fibula horizontally, and that of the lower flap and os calcis vertically (No. 7, Fig. 12); while others cut the lower flap and these bones obliquely, the first in a downward and forward direction, the os calcis in a similar direction (No. 8, Fig. 12). By this last means the dense skin covering the under-surface of the heel sustains the superjacent weight, and not, as in the former, the more delicate covering of the posterior surface of the heel. This operation is not regarded with much favour by many surgeons, because the flap requires very delicate adjustment, and because in some cases there is risk of caries of the fragment.

The stump left after Pirogoff's amputation is, according to the makers of mechanical appliances, better than that left after Hey's, Lisfranc's, Chopart's, or Syme's amputation. Mr. Heather Bigg describes the apparatus used after Pirogoff's amputation as one of the most perfect in the range of mechanical appliances.



Fig. 14 shows the position of the medio-tarsal articulation, and of the bones entering into its formation.

CHOPART'S AMPUTATION.

In Chopart's Amputation, or *medio-tarsal disarticulation*, the front of the foot is removed at the medio-tarsal articulation. Posteriorly this joint is formed by the convex head of the astragalus internally, and externally by the concavo-convex anterior surface of the os calcis, and anteriorly by the concave posterior surface of the scaphoid on the inner side, and on the outer side by the irregular posterior surface of the cuboid. See Fig. 14.

The direction of the upper limit of this articulation is not transverse, its inner half being convex anteriorly, its outer half concave in the same direction.

The inner limit of the joint is situated immediately behind the tubercle of the scaphoid, and corresponds in a foot of average size to a point one inch in front of the inner malleolus or to a point midway between the malleolus and the base of the first metatarsal bone. In most feet it is not difficult to feel the tuberosity.

The outer limit of the articulation is also situated one inch in front of the outer malleolus, or midway between the malleolus and the base of the fifth metatarsal bone. It can be felt as a distinct prominence, which is formed partly by the os calcis and partly by the cuboid.

Steps of the Operation.

1. Grasp the front of the foot in the left hand, indicating with the tips of the thumb and forefinger the inner and outer limits of the articulation. Then taking care that your incision begins and ends fairly in the sole of the foot, join these two points by an incision across the dorsum of the foot, having a slight convexity forwards. See Fig. 15.

In so doing you divide *superficial fascia*, containing from without inwards the *external saphenous nerve*, the branches of the *musculo-cutaneous nerve*, and the *internal saphenous nerve*; also accompanying the nerves of the same name, the terminations of the *external and internal saphenous veins*.

Cutaneous branches of the *external plantar, tarsal, external malleolar, anterior peroneal, internal malleolar, and internal plantar arteries* may also be seen in section.

2. Having retracted the skin and superficial fascia sufficiently, cut through the structures lying superficial to the medio-tarsal articulation. These are from without inwards a

portion of the outer division of the *plantar fascia*, with a little of the *abductor minimi digiti* lying beneath it; the *deep fascia*, with the lower limit of the *anterior annular ligament*, covering in the tendons of the *peroneus longus* and *brevis*, the *extensor brevis digitorum* covered by the tendons of the *peroneus tertius* and *extensor longus digitorum*, the tendons of the *extensor longus pollicis* and *tibialis anticus*, and still more internally a portion of the *inner division of plantar fascia* and the subjacent *abductor pollicis* are cut through.

The *dorsalis pedis* artery is seen between the tendon of the *extensor proprius pollicis* and the long *extensor of the toes*. Further branches of the *external plantar* and other arteries already mentioned are seen in the superficial fascia.

The inner division of the *anterior tibial nerve* is seen lying internal to the *dorsalis pedis* artery, and the *outer division* is seen cut in the substance of the *extensor brevis digitorum*.

3. Now cut through the ligaments covering in the articulation

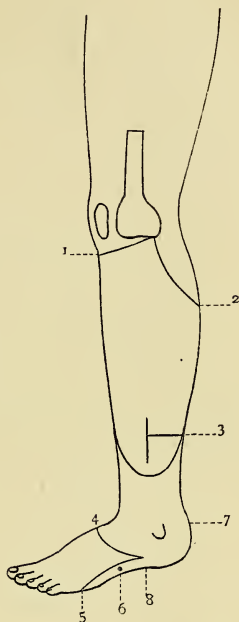


Fig. 15. Outer aspect of left leg.

7 indicates the position of the external malleolus, and 6 the posterior extremity of the fifth metatarsal bone. 8 is placed immediately below a point midway between the tip of the external malleolus and the projecting base of the fifth metatarsal, and corresponds therefore to the angle of junction of the dorsal and plantar flaps in Chopart's operation.

above, namely, the *superior calcaneo cuboid*, the *internal calcaneo cuboid*, which is placed deeply in the hollow between the astragalus and os calcis, and is closely connected with the next ligament to be divided, the *external calcaneo scaphoid*. Lastly, the *superior calcaneo scaphoid* is cut through.

4. Now shape a large plantar flap, commencing by cutting from the inner end of the dorsal incision along the inner margin of the foot, along the anterior limit of the sole, and along the outer margin of the sole to the outer extremity of the dorsal incision, cutting the flap longer internally than externally. Dissect this flap up from the bones till you reach the level of the medio-tarsal articulation. In making this flap you will divide *superficial fascia*, which is thick and contains masses of fat separated by fibrous septa. In this fascia you divide branches of the *internal saphenous nerve*, *internal and external plantar and external saphenous nerves*, also branches of the *internal and external saphenous veins*, and branches of the *internal plantar, external plantar, tarsal, and metatarsal arteries*.

In raising the flap from the bones, you divide the *inner division of the plantar fascia* with the *abductor pollicis* beneath it, the five processes of the *middle division of the plantar fascia*, bifurcating to enclose the tendons of the *flexor longus* and *flexor brevis digitorum*, and the tendon of the *flexor longus pollicis*. All these tendons are divided here with their coverings of synovial membrane. Between these processes of plantar fascia are divided the termination of the *internal plantar artery and veins*, the digital branches of the *external plantar artery and veins*, and the *tendons of the lumbricales*.

The *outer division of plantar fascia* with the subjacent *abductor minimi digiti* are also divided. In raising the

flap still further small portions of the *transversus pedis*, *flexor brevis pollicis*, *adductor pollicis*, *outer interossei muscles*, and the *flexor brevis minimi digiti* may be removed in the flap. The deep division of the *external plantar artery* will be divided with the accompanying veins and nerve on the bases of the second or third metatarsal bones. The *tibialis posticus* will now be divided with the process passing back from it to the *sustentaculum tali*.

5. Now cut through the *inferior calcaneo scaphoid* and the long and short plantar ligaments, and the operation is complete.
6. Bring the flaps together with sutures and introduce drainage tubes.

Some surgeons prefer to open the joints from the dorsum, and afterwards make the plantar flap by cutting from within outwards, while others shape the plantar flap by cutting through the skin and superficial fascia before doing so.

LISFRANC'S AMPUTATION.

The metatarsal is removed at the tarso-metatarsal articulation.

Steps of the Operation.

1. First define the position of the projecting base of the fifth metatarsal bone, and then that of the base of the first metatarsal. The former is easily found, but the latter cannot always be felt so easily. It corresponds to the centre of the inner margin of the foot, and lies about an inch in front of the tuberosity of the scaphoid.
2. Grasp the front of the foot so that the points of the index finger and thumb indicate the articulations at each margin of the foot. Make a slightly curved incision, beginning

and ending well in the sole of the foot immediately in front of these articulations. See Fig. 16.

In doing this you divide *skin* and *superficial fascia*, containing from without inwards branches of the *external saphenous*, *musculo-cutaneous*, and *internal saphenous nerves*, with *small branches* of veins and arteries.

3. Reflect the skin and superficial fascia to the level of the

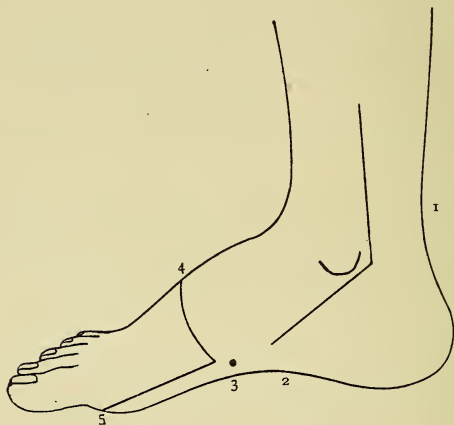


Fig. 16. Inner aspect of right foot and ankle.

3 indicates the position of the inner limit of the tarso-metatarsal articulation.

4 and 5 represent the dorsal and plantar flaps in Hey's or Lisfranc's operations.

articulation, and divide the structures lying superficial to the bones and ligaments by a transverse incision. Then open the joints between the fifth metatarsal and cuboid, and between the first metatarsal and internal cuneiform bones, so as to make sure of the line of the articulation.

In doing this you divide *deep fascia*, externally a little of the *outer division* of the *plantar fascia*, and internally a

little of the *inner*, as your incision extends well into the sole of the foot. Beneath these a little of the *abductor minimi digiti*, the tendon of the *peroneus brevis* at its insertion, the tendon of the *peroneus tertius*, the tendons of the *extensor longus digitorum*, beneath these the tendons of the *extensor brevis digitorum*, the slip to the great toe being divided internal to the innermost tendon of the *extensor longus digitorum*, the *extensor longus pollicis*, the *tibialis anticus*, where it is inserted into the inner aspect of the base of the first metatarsal bone, and a small portion of the *abductor pollicis*.

The *dorsalis pedis* artery is divided immediately beneath the slip of the *extensor brevis digitorum*, which goes to the great toe, and the *metatarsal artery* just external to it. The division of the *anterior tibial nerve*, which supplies the adjoining sides of the great and second toes, is cut as it lies just internal to the dorsal artery. In opening the marginal articulations, the *dorsal tarso-metatarsal ligaments* are divided.

4. Commencing at the outer extremity of the dorsal incision, cut along the outer margin of the fifth metatarsal bone, and then obliquely outwards and forwards across the sole just behind the roots of the toes, and then backwards along the inner border of the first metatarsal to the inner extremity of the dorsal incision. The outer part of the flap is not to be as long as the inner. In making this incision cut at once down to bone. Now reflect this flap from the under surface of the metatarsal bones to the level of the tarso-metatarsal articulation.

In shaping the flap you divide in order from within outwards, *skin*, *superficial fascia*, containing branches of the *internal* and *external saphenous nerves*; the *inner* division of *plantar fascia*, the five processes of the *middle*

division connected by the *superficial transverse ligament*, and the *outer division*; the *abductor pollicis*, the *inner head* of the *flexor brevis pollicis*, the *tendon* of the *flexor longus pollicis*, the *outer head* of the *flexor brevis pollicis*, the *adductor pollicis*, the *tendons* of the *flexor brevis digitorum*, those of the *flexor longus digitorum* beneath the *tendons* of the *flexor brevis digitorum*, the *lumbricales*, the *transversus pedis*, the *flexor brevis minimi digiti*, and the *abductor minimi digiti*; *internal* to the *flexor longus pollicis*, the *termination* of the *internal plantar artery*, with the *digital branch* of the *internal plantar nerve* to the *inner side* of the *great toe*; the *digital branches* of the *external plantar artery* between the *five processes* of the *middle division* of the *plantar fascia*, and one between the *middle* and *outer divisions* of this *fascia*; accompanying the *three inner digital arteries*, the *digital branches* of the *internal plantar nerve*, and with the *two outer digital branches* of the *external plantar nerve*.

In raising the flap, you divide the *flexor brevis pollicis* near its origin, and remove the *adductor pollicis* from the bases of the second, third, and fourth metatarsal bones, also a portion of the *flexor brevis minimi digiti* from the fifth metatarsal.

The *external plantar artery* and *nerve* are divided as they pass inwards beneath the *tendons* of the *flexor longus digitorum*.

5. You must now remember that the base of the second metatarsal bone is wedged in between the three cuneiform bones, and that the third metatarsal articulates with the external cuneiform on a plane slightly anterior to that of the fourth and fifth. The interosseous ligaments connecting the second metatarsal and internal cuneiform bone are easily divided by inserting the knife up through

the space between the first and second metatarsal bones, and cutting directly backwards. Previous to doing this the flaps are drawn well back by an assistant. Now grasp the metatarsus firmly, press it downwards, and scratch with the point of the knife through the dorsal ligaments of the joints. Having opened them, flex the metatarsus still further, and divide the inferior ligaments with the tendon of the peroneus longus, and the operation is complete.

In doing this, you divide the *interossei* muscles in the back of the first space, with the *dorsal artery and veins*, the *dorsalis hallucis* and *first plantar digital arteries* at their origin, and then the *inner* and largest of the *interosseous tarso-metatarsal ligaments*. This extends from the outer side of the first cuneiform to the inner side of the second metatarsal bone, close to its articular surface. Then those *dorsal tarso-metatarsal ligaments* not yet divided are cut through, with the *external interosseous ligament* which connects the outer side of the external cuneiform to the same side of the third metatarsal and very strongly to the inner side of the fourth metatarsal bones. Occasionally a small interosseous ligament between the opposing aspects of external cuneiform and second metatarsal bones is present, and requires to be divided.

The *inferior tarso-metatarsal* and the *long calcaneo cuboid* ligaments, the tendon of the *peroneus longus* and its *synovial* covering are then divided, also tendinous slips from the tendon of the *tibialis posticus* to the second, third, and fourth metatarsal bones.

In the foot, as in the hand, the metatarsal bones, commencing with the first and ending with the fifth metatarsal, articulate with one, three, one, two, one tarsal bones respectively. See Fig. 17.

In Hey's amputation the incisions are similar to those in Lisfranc's operation, except that the metatarsal bones are sawn through in front of their bases, instead of being disarticulated.

AMPUTATION OF THE GREAT TOE.

OVAL METHOD.

Steps of the Operation.



Fig. 17 shows the lines of the incisions for the amputation of the great toe by the oval method. The dark continuous line and its bifurcations show the direction of the incisions along the dorsum of the foot, and the dotted line its direction along the plantar aspect.

1. Define the position of the articulation between the internal cuneiform bone and the base of the first metatarsal bone. This articulation is frequently hard to feel; it corresponds to a point midway between the extremities of the heel and great toe. See Fig. 17.
2. Make an incision along the inner aspect of the dorsum of the first metatarsal bone, from a point half an inch behind the tarso-metatarsal articulation to the centre of the metatarsal bone. Continue the incision obliquely outwards and forwards to the centre of the web between the great and second toes, then transversely inwards across the plantar surface of the toe, along the natural fold present in this situation, and continue it upwards and backwards to the lower extremity of the longitudinal incision, cutting down to bone in the whole extent of the section.

You divide *skin*; *superficial fascia* containing branches of the *internal saphenous*, inner division of the *musculo-cutaneous*.

neous, and digital branches of the *internal plantar nerves*, branches of the *dorsalis hallucis*, *first plantar digital* and the termination of the *internal plantar arteries*; *deep fascia*, *inner division of plantar fascia*, and the *inner divided fasciculus of the middle division of the plantar fascia*, with the *superficial transverse ligaments*; beneath these the tendon of the *extensor proprius pollicis*, the *vaginal sheath*, the tendon of the *flexor longus pollicis* contained in it, and its *synovial sheath*.

3. Reflect the inner flap from the metatarsal bone and base of the first phalanx, and then clear these bones on their inferior and outer aspects, avoiding any injury to the *dorsalis pedis artery*, as it passes to the sole between the two heads of the first dorsal interosseous. Divide the ligaments connecting the metatarsal bone to the internal cuneiform, and remove the toe.

In doing this you cut through the *abductor pollicis* at its insertion, where it is covered by the *inner division of the plantar fascia*; beneath it the inner head of the *flexor brevis pollicis*, behind the sesamoid bone, with further branches of arteries already described.

In separating the bone from the structures on its outer aspect, you cut through the *outer head of the flexor brevis pollicis* and the *adductor pollicis* immediately behind the outer sesamoid bone, together with the *transversus pedis*, which is closely blended with the last-named muscle at its insertion; the *deep transverse ligament*; the *innermost tendon of the extensor brevis digitorum*, and the *first dorsal interosseous muscle* where it arises from the outer side of the first metatarsal bone. Lastly, you cut through the insertion of the *tibialis anticus* into the inner side of the base of the first metatarsal, the *peroneus longus* into the lower and outer angle of its base, and the *dorsal and plantar ligaments* connecting this bone to the internal cuneiform.

FLAP AMPUTATION OF GREAT TOE.

Steps of the Operation.

1. Holding the great toe in your left hand, make an incision along the dorsal aspect of the metatarsal bone, commencing just behind the tarso-metatarsal articulation. Having reached the head of the bone, cut downwards over its inner aspect, and then backwards along the under surface of the metatarsal bone to a point directly below the commencement of the incision. Reflect this flap to the level of the articulation of the metatarsal bone with the internal cuneiform bone.
2. Open this articulation from the inside, dividing the dorsal and plantar ligaments, and the insertion of the tibialis anticus.
3. Introduce the knife between the bases of the first and second metatarsal bones, through the angles of the flap already cut, and divide the soft structures to the centre of the web.
4. Grasping the metatarsal bone firmly and pulling it inwards, divide the insertion of the peroneus longus, and any ligamentous bands still retaining the bone in position. In doing so, you carefully avoid the dorsalis pedis artery.

In doing this operation you divide the same structures as you do in the oval method, except *that those in the sole are cut through more posteriorly*. You also divide branches of arteries, which can be turned off the bone in the latter operation. They are the *first plantar digital* and the *dorsalis hallucis*.

AMPUTATION OF THE LITTLE TOE AT THE TARSO-METATARSAL ARTICULATION.

Steps of the Operation.

1. Define the position of the projecting base of the fifth metatarsal, and the direction of its articulation with the cuboid. See Fig. 17.
2. Enter the point of the knife just behind the tuberosity on the base of the fifth metatarsal bone, and cut first forwards and inwards along the articulation between the base of the fifth metatarsal and cuboid, and then forwards along the centre of the fourth digital interspace to the centre of the web between the fourth and fifth toes. Continue this incision outwards along the plantar surface of the first phalanx, and then turn upwards and inwards, joining the dorsal incision in the centre of the interspace.

In making this incision you divide skin, superficial fascia containing branches of the external saphenous, of the external branch of the musculo-cutaneous, and digital branches of the external plantar nerves, the collateral branches of the dorsal digital arteries, and the digital branches from the external plantar artery. Radicles of the external saphenous vein and lymphatics are also cut through. You also divide on the dorsum of the foot deep fascia, posteriorly the tendon of the peroneus tertius, just behind its insertion into the base of the fifth metatarsal; anteriorly the outer tendon of the extensor longus digitorum with the tendinous expansion from the interosseous and lumbrical joining it; on the under surface of the toe two processes of the outer fasciculus of the middle division of the plantar fascia, a portion of the outer division of

the plantar fascia, the vaginal sheath, and the tendons of the flexor sublimis and profundus digitorum enclosed in it.

3. Turn the convex outer flap down from the upper, outer, and under surfaces of the metatarsal bone, separating the flexor brevis minimi digiti from the base of the bone, and dividing it with the tendon of the abductor minimi digiti at their insertion into the base and external border of the first phalanx.
4. Cut away the fourth dorsal interosseous muscle from its origin from the inner side of the fifth metatarsal bone, avoiding the interosseous branch of the metatarsal artery and the digital branch of the external plantar artery to this space. Also divide the transversus pedis where it arises from the inner lateral metatarso-phalangeal ligament, and the deep transverse metatarsal ligament at its attachment to the head of the fifth metatarsal.
5. Divide the insertion of the peroneus brevis into the projecting base of the fifth metatarsal, the abductor ossis metatarsi minimi digiti, which is so frequently present, the dorsal and plantar cubo-metatarsal ligaments, and the dorsal, plantar, and interosseous inter-metatarsal ligaments.

Amputations of the toes at the tarso-phalangeal articulations are performed in the same manner as are the corresponding operations in the hand, and almost exactly the same structures are divided. The head of the metatarsal bone should always be removed.

SECTION II.—AMPUTATIONS OF UPPER EXTREMITY.

AMPUTATION THROUGH SHOULDER JOINT.

OVAL METHOD.

Steps of the Operation.

1. Place the patient on the opposite side. An assistant holding the arm from the side, make a vertical incision in the centre of the outer aspect of the shoulder between one and a half and two inches long, commencing above at the outer margin of the acromion. Cut at once down to bone. You divide, in doing this, *skin, superficial fascia*, containing branches of *supra-acromial* and *circumflex nerves*, *deep fascia, deltoid*, with branches of *posterior circumflex artery* and *circumflex nerve* in its substance; beneath it a *bursa*, acromial branches of the *acromio-thoracic artery*, the tendon of the *supra-spinatus* blended with the *capsule* of the joint, with further branches of the *posterior circumflex artery*.
2. The subclavian artery being controlled by an assistant, make from the lower extremity of this incision another running obliquely downwards and inwards, cutting to the anterior fold of the axilla where it joins the upper arm, in fact to the lower border of the *pectoralis major*. Continue this incision down to the bone, dividing, in so doing, *skin, superficial fascia* with filaments of the *supra-acromial* and *circumflex nerves*, *deep fascia*, and beneath it portions

of the *deltoid* and *pectoralis major*. Between these two muscles the *cephalic vein* and humeral branch of the *acromio-thoracic artery* are divided, and beneath them a layer of fascia and branches of the *acromio-thoracic artery*. Then you cut through the *long head of the biceps*, with the *latissimus dorsi* and *teres major* at their insertions. The *anterior circumflex artery* is divided on the bone, and a *bursa* between the two last-mentioned muscles cut through.

3. Make another incision commencing also at the lower extremity of the vertical incision, running obliquely over the outer and posterior aspect of the shoulder downwards and backwards to the arm at the junction with it of the posterior fold of the axilla—namely, to the lower border of the *teres major* and *latissimus dorsi*; cut right down to bone. You divide in so doing *skin*, *superficial fascia*, containing branches of the *supra-acromial* and *circumflex nerves*, *deep fascia*, *deltoid*, and beneath it branches of the *circumflex nerve* and *posterior circumflex artery*, and the upper extremity of the *outer and long heads of the triceps*.
4. The assistant now rotates the humerus outwards, at the same time adducting it, and pulling the head from the glenoid cavity. Divide the structures inserted into front part of the upper end of the humerus—namely, the portion of the *supraspinatus* in front of the vertical incision with the subjacent and attached *capsule*, the *coraco* and *gleno-humeral ligaments*, the tendon of the *biceps* a second time, and the descending branch of the *anterior circumflex artery* running with it, the *subscapularis* in front of this with the *bursa* beneath it, and the subjacent *capsule*.
5. The assistant rotating the humerus inwards, divide the structures attached to the back and outer part of the upper end of the humerus—namely, portion of the

supraspinatus behind the median incision, the *infraspinatus* and the *teres minor*, with the subjacent *capsule* to which these tendons are closely united. Beneath the *teres minor* you usually divide a *bursa*, which may communicate with the joint.

6. While the assistant pulls the head of the bone outwards from the glenoid cavity, you divide the attachment of the capsule to the lower part of the neck of the humerus, and then cut downwards and inwards to the lower extremities of the second and third incisions, so liberating the arm from the trunk. The wound so formed is pear-shaped, its apex corresponding to the upper extremity of the vertical incision. In this third flap you have the artery, and you can now tie it or twist it and any of its branches that may require it. In cutting this flap you divide from above downwards the *capsule* of joint, the short head of the *biceps* with the *coraco-brachialis*, in the substance of the *coraco-brachialis* the *external circumflex nerve*, and beneath it the *anterior circumflex artery*. The *axillary artery* is divided at its termination lying on the *coraco-brachialis* with the *axillary vein* lying to its inner side. Superficial to the artery the *median nerve* is divided, and, internal to the axillary artery and vein, the *ulnar*, *internal cutaneous*, *small internal cutaneous*, and *intercosto-humeral nerves* are divided, and, behind it, the *musculo-spiral nerve*. The *deep fascia* is then cut through, and lastly the *superficial fascia*.

AMPUTATION THROUGH SHOULDER JOINT.

DOUBLE FLAP METHOD.

Steps of the Operation.

1. An assistant raises the arm from the side, and rotates it in-

- wards. Carefully define the position of the coracoid process and of the acromion, and using a long amputating knife, enter its point midway between the tip of the acromion and that of the coracoid process. The point of the knife has to pass over the head of the bone, over the outer and then over the posterior surface of the humerus, in order to emerge just in front of the posterior fold of the axilla immediately below the insertion of the latissimus dorsi, so that, as you proceed in passing the knife, you alter the direction of its point.
2. The deltoid is now raised in your left hand, and you gradually cut outwards along the humerus, forming an oval flap about three or four inches long. In this flap you cut through a great part of the *deltoid*, the *bursa* beneath it, the *outer* and *long* heads of the *triceps*, the lower limits of the tendons of the *latissimus dorsi* and *teres major*, with their expansion to the deep fascia, which is divided superficially to these muscles. In the upper part of the incision, you divide the acromial branch of the *acromio-thoracic artery*, and in the lower part the main trunk or the divisions of the *posterior circumflex artery* and *circumflex nerve*. In the superficial fascia branches of the *circumflex nerve* are divided.
 3. This flap is now raised by one assistant, while the other draws the arm downwards and forwards. Cut through the *supraspinatus*, *infraspinatus*, and *teres minor* with the upper and back part of the *capsule* of the joint, and more anteriorly the *long* head of the *biceps* with the ascending branch of the *anterior circumflex artery*.
 4. By rotating the humerus forcibly outwards, the *subscapular* muscle may also be divided at its insertion in the lesser tuberosity. The subclavian artery being carefully compressed, the head of the humerus is forced well out of the

glenoid cavity, and the humerus approximated somewhat to the side. Divide the lower and anterior portion of the capsule, and cut downwards along the inner surface of the humerus, keeping close to it. Then turn the edge of the knife obliquely inwards, and cut towards the inner aspect of the arm, so making an oval flap. As you cut inwards an assistant grasps the upper part of the flap, and easily compresses the axillary artery.

In cutting this flap you divide in order the remainder of the *deltoid*, the *pectoralis major*, the *cephalic vein*, the humeral branch of the *acromio-thoracic artery* in the interval between these muscles, the *short head* of the *biceps*, the *coraco-brachialis*, and the *latissimus dorsi* and *teres major* muscles at their insertion together with the intervening and subjacent *bursæ*.

The *anterior circumflex artery* is divided as it passes outwards on the humerus beneath the *coraco-brachialis*. The *brachial artery* is divided as it lies on the *coraco-brachialis*, and the *axillary vein* to its inner side. Internal to the artery are divided the *ulnar, internal, lesser internal cutaneous nerves* with the *nerve of Wrisberg*, behind the artery the *musculo-spiral nerve*, and in substance of the *coraco-brachialis* the *external cutaneous nerve*. Superficial to the axillary artery you cut through the *median nerve*, and behind the artery at the upper margin of the *latissimus dorsi*, the *circumflex artery* and *posterior circumflex nerve* as they enter the quadrilateral space.

This operation is not performed frequently; first, because it requires the leverage action of the humerus—and this is usually broken in cases demanding amputation; and in the case of amputation for tumours of the humerus, transfixion is impossible. For these conditions the oval method is much more appropriate.

AMPUTATION THROUGH THE ARM.

DOUBLE FLAP AMPUTATION.

Steps of the Operation.

1. An assistant holds the arm at right angles to the trunk. Standing on the inner side of the arm, carefully define the position of the brachial artery. (This amputation is through the centre of the arm.) Enter the point of the knife in front of this vessel with a direction towards the outer surface of the bone, with the blade parallel to it, one inch below the intended division of the humerus. Having reached this, raise the handle of the knife, keeping its point on the bone. Pass it on through the soft structures till you perforate the skin of the arm at a point exactly opposite to that in which you entered the knife. Now cut downwards, first longitudinally for a short distance, then obliquely towards the surface, so as to bring the knife out at a right angle to the plane of the arm. The length of the flap should be about three inches. See Fig. 18 and Fig. 19. In cutting this flap you divide the *biceps* with the *brachialis anticus* beneath it and to its outer side, and between the two the *external cutaneous nerve*. Behind the *brachialis anticus* the *external inter-muscular septum*, with portions of the *outer* and *inner* heads of the *triceps* and the *musculo-spiral nerve* are divided. In some cases the *musculo-spiral nerve* may not be divided. With it is divided the terminal branch of the *superior profunda artery*. The *lower external cutaneous* of the *musculo-spiral* is divided as it lies on the *triceps*. Superficial to the muscles *deep fascia* is divided, and you cut through in the superficial fascia the *cephalic vein* and *lymphatics*

with the *upper external cutaneous* of the *musculo-spiral* in the outer aspect of the arm, and branches of the *circumflex* and *internal cutaneous* nerves on the anterior aspect.

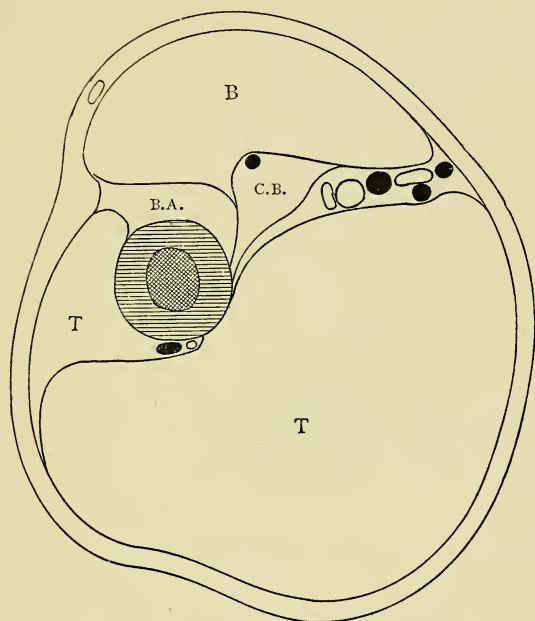


Fig. 18 is a transverse section through the centre of the left upper arm.

The external cutaneous nerve is seen as it lies between the coraco-brachialis and the biceps, the musculo-spiral nerve and superior profunda artery as they groove the humerus between the inner and outer heads of the triceps, the brachial artery and vein, the median, internal cutaneous and ulnar nerves with the basilic vein between the triceps, coraco-brachialis, and biceps.

2. An assistant holds this flap, taking care not to raise it too much and so interfere with your passing the knife around the bone. Pass the point of the knife into the upper

and internal limit of the anterior incision behind the humerus, then depress the handle and keep the point of the knife close to the surface of the bone till you reach

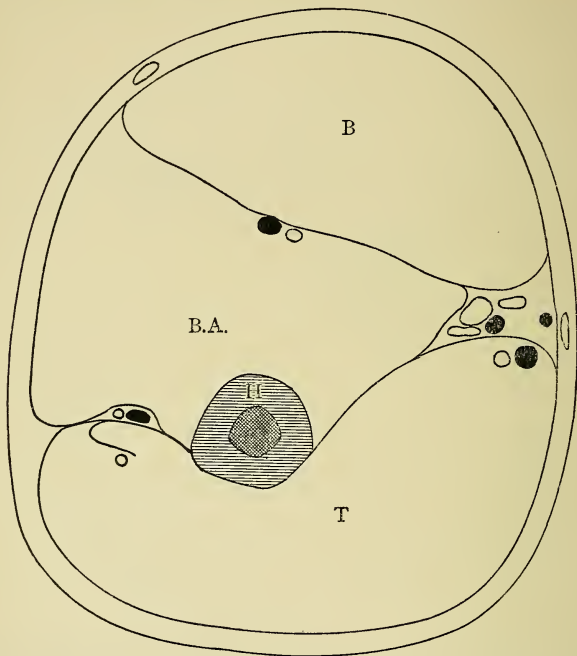


Fig. 19 is a transverse section of the upper arm through the middle of its lower third.

The ulnar nerve and inferior profunda artery are seen behind the internal intermuscular septum, and the superior profunda artery and musculo-spiral nerve are seen perforating the external intermuscular septum. The external cutaneous lies between the biceps and brachialis anticus.

the outer portion of the first incision. Cut downwards and then backwards, forming a flap like the first, but not quite so long. In doing this you divide possibly a

little of the inner portion of the *biceps* and the inner part of the *brachialis anticus*, the *coraco-brachialis*, should it be very largely developed, the *internal intermuscular septum*, and the *triceps*. On the *brachialis anticus* the *brachial artery* is divided with its *venae comites*, superficial to it the *median nerve*, internal to it the *internal cutaneous*, and still more internal to it, and lying on the *intermuscular septum*, the *ulnar nerve*, *ulnar collateral nerve*, and *inferior profunda artery*. In the *triceps* are divided the *internal muscular branch* of the *musculo-spiral* with the branch to the *anconeus*, accompanied by the *posterior articular artery*. The *deep fascia* is then divided with the *superficial fascia*, containing the *basilic vein* and *lymphatics* with it, the *lesser internal cutaneous*, *intercosto-humeral*, *internal cutaneous* of the *musculo-spiral*, and small branches of the *circumflex nerves*.

3. The flaps are now retracted by an assistant. Separate the soft structure for nearly an inch above the angles of the incision, divide the periosteum by a circular incision, and saw through the bone.

If the patient is a very muscular subject it may be preferable to cut the flaps from without inwards, or perform a circular amputation.

Should the arm be amputated below its centre, see Fig. 19 for structures cut through.

AMPUTATION THROUGH THE ARM.

CIRCULAR METHOD.

Steps of the Operation.

1. An assistant holds the arm at right angles to the trunk. Stand behind the arm, grasp the limb with the left hand,

and make a circular incision through the skin and superficial fascia at least three inches below the point at which you intend to divide the humerus, and in this description this point will be the centre of the bone. In the superficial fascia you divide the *cephalic vein*, with the *lymphatics* and the *upper external cutaneous* of the *musculo-spiral nerve* accompanying it in the outer part of the anterior surface of the arm; in the inner part of the anterior surface the *basilic vein*, with *lymphatics* (perhaps the *supracondyloid gland*) and the *internal cutaneous nerve*; inside this the *nerve of Wrisberg* and the *intercosto-humeral nerve*; and on the posterior aspect of the arm branches of the *nerve of Wrisberg*, *internal cutaneous*, and the *lower external cutaneous* of the *musculo-spiral*. See Fig. 18 and Fig. 19.

2. The assistant retracting the skin and superficial fascia, make a circular incision down to bone through the soft structures at a level of about an inch and a half above the skin incision.
3. The assistant again drawing up the skin, superficial fascia, and muscle, so as to make the bone project covered by muscle, make another circular incision down to the bone and periosteum.

In these two circular incisions you divide *deep fascia*, and attached to its deep surface on the inner aspect of the arm the *internal intermuscular septum*, and on the outer the thinner *external intermuscular septum*. Behind the *internal septum* and attached to it you divide the *inner head* of the *triceps*, and between the two the *ulnar nerve*, *ulnar collateral* and *inferior profunda artery*; on the posterior surface of the humerus, between it and the triceps, the *posterior articular artery* and the *nerve to the anconeus* accompanying it; behind the external intermuscular septum and attached to it the *inner head* of the *triceps*, with a branch of the

superior profunda which passes behind the outer condyle; in front of this septum and attached to it the *brachialis anticus*, *supinator longus*, and probably a portion of the *extensor carpi radialis longior*; and between these two last muscles and the *brachialis anticus* the *musculo-spiral nerve* with branches to these three muscles, and the termination of the *superior profunda artery*. You divide more internally the *biceps* with the *brachialis anticus* beneath it, and between them the *external cutaneous nerve*, the *brachial artery* with its *venæ comites*, lying on the *brachialis anticus* beneath the *biceps* and internal to the artery the *median* and *internal cutaneous nerves*. The *anastomotica magna artery* may also be divided as it passes inwards on the *brachialis anticus*. The *brachialis anticus* is seen to have a more extensive attachment to the anterior surface of the strong internal inter-muscular septum than it has to the thinner external septum. *Nutrient* vessels to the bone will be divided on turning back the flap.

4. The soft structures must now be drawn well back from the bone, the periosteum turned up off the bone for about half an inch or more, and the bone sawn through. The shape of the wound will be that of a cone, the extremity of the humerus forming its apex.

AMPUTATION THROUGH ELBOW JOINT.

FLAP METHOD.

Steps of the Operation.

1. The arm is held by an assistant in a supinated and slightly flexed position. At the same time he draws up the skin of the forearm by gripping the upper arm in his left hand.

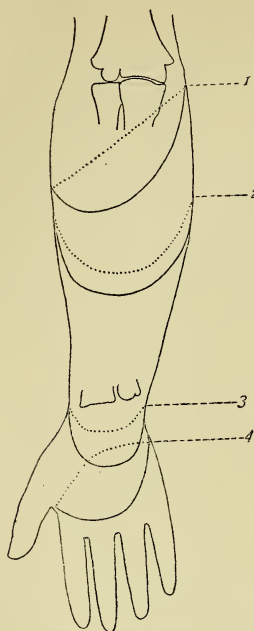


Fig. 20 is a diagram of the anterior surface of the right forearm and hand.

1 indicates the incisions in the flap amputation through the elbow joint, the dotted line representing the posterior incision, and the continuous line the anterior.

2 indicates the anterior and posterior incisions in the flap amputation through the forearm. The inner extremity of the dotted line representing the posterior incision extends a little too high up in the drawing.

Define the position of the condyles, and of the articulation between the humerus and the radius and ulna. See Fig. 20.

2. Stand on the inner aspect of the arm, which is abducted at a right angle from the side. Enter the point of a long, narrow amputating knife in the inner aspect of the forearm, and an inch below the internal condyle. Pass it downwards and outwards across the front of the ulna and radius, so that it emerges at a point two inches below the external condyle. Cut downwards and then forwards, shaping a semilunar flap.

In doing this you cut through *skin*; *superficial fascia* containing branches of the *internal cutaneous*, *external cutaneous*, and *lower external cutaneous* of the *musculo-spiral nerves*, and branches of the *ulnar median* and *radial veins*; *deep fascia*, the *aponeurotic band* from the inner margin of the tendon of the *biceps* and *intermuscular septa*; in trans-

fixing the arm you cut the *flexor carpi ulnaris*, *flexor profundus digitorum*, *flexor longus pollicis*, *flexor sublimis digitorum*, *pronator radii teres*, *supinator brevis*, *extensor carpi radialis brevior* and *longior* and the *supinator longus*; and in cutting the flap, further portions of these muscles with the *palmaris longus*, and the *flexor carpi radialis*, you cut through the *ulnar artery* and *venæ comites* on the *flexor profundus digitorum*, the *common interosseous trunk*, as it passes backwards between the two deep muscles; the *radial artery* and *venæ comites* between the *pronator radii teres* and the *supinator longus*, lying upon the *flexor sublimis digitorum*, the *radial nerve* on the outer side of the artery, the *median nerve* and *comes nervi mediani* beneath the *flexor sublimis*, and its *anterior interosseous branch* passing between the two deep muscles.

3. An assistant raises the anterior flap, pulling the skin of the forearm upwards. Clear the muscles from the front of the radius and ulna till the outer angle of the incision reaches the level of the radio-ulnar articulation. Open that articulation from the front and side.

You divide further portions of the *supinator brevis*, *pronator radii teres*, *flexor sublimis digitorum*, and the long head of the *flexor longus pollicis*, the *biceps* and *brachialis anticus* at or above their insertions, the *posterior interosseous nerve* in the *supinator brevis*, branches of the *radial*, *anterior* and *posterior ulnar recurrent arteries*; the *external lateral ligament*, and portions of the *anterior* and *orbicular ligaments* of the joint.

4. The forearm being completely flexed, join both upper extremities of the anterior flap by a straight incision down to the bone across the back of the elbow joint. In so doing you divide *skin*, *superficial fascia* containing branches of the *upper external* and *lower external cutaneous* of the

musculo-spiral nerve, branches of the *intercosto-humeral* and *lesser internal cutaneous*, and *internal cutaneous nerves*; *deep fascia* with *intermuscular septa*; the *extensor carpi radialis brevior*, *extensor communis digitorum*, *extensor carpi ulnaris*, *anconeus*, *triceps*, *subanconeus*, and the *flexor carpi ulnaris*; the *ulnar nerve*, with branches of the *inferior profunda*, *anastomotica magna*, and *posterior ulnar recurrent arteries*; the *nerve* to the *anconeus* and the *posterior articular artery* and veins beneath the *triceps*, and branches of the *anastomotica magna*, *superior profunda*, and *interosseous recurrent arteries* behind the *external condyle*.

5. Divide the remaining ligaments of the joint—namely, the remainder of the *anterior ligament*, the *posterior ligament*, and the *internal lateral ligament*.

This operation is described by Mr. Norton in his text book of operative surgery. He says that the great obliquity of the base of the flap is effaced in the living subject by the more extensive retraction of the tissues on the outer side of the arm. It is superior to the usual flap operation

AMPUTATION THROUGH ELBOW JOINT.

CIRCULAR OPERATION.

Steps of the Operation.

1. The arm is supinated, and held by an assistant. Make a circular incision through the skin and superficial fascia at a point two inches below the internal condyle, and reflect these structures from the deep fascia to the level of the joint, which you must remember is placed very obliquely, being considerably lower on the inner than on the outer side of the arm. In the superficial fascia you divide in

front of the arm the anterior branch of the *internal cutaneous nerve*, with the anterior and posterior branches of the *ulnar vein*; externally the anterior and posterior branches of the *external cutaneous nerve*, and of the *radial vein*, in the middle line the *median vein* and its communication with the deep veins.

On the posterior surface are divided externally the branches of the posterior division of the *external cutaneous nerve* and branches of the *radial vein*, branches of the *upper and lower external cutaneous branches* of the *musculo-spiral*, and internally branches of the *internal cutaneous* and *lesser internal cutaneous nerves* and of the *ulnar vein*.

2. The skin and superficial fascia being held by an assistant, cut through the *deep fascia*, the *aponeurosis* from the *biceps*, and the structures lying in front of the joint. They are from without inwards the *supinator longus*, and beneath it the *exterior carpi radialis longior* and *brevior*; internal to the *supinator longus* the anterior part of the *supinator brevis*, and between the two the *radial* and *posterior interosseous nerves*, and branches of the *radial recurrent*, and *superior profunda arteries*. Internal to the *supinator brevis* you divide the tendon of the *biceps* with the termination of the *brachial artery* and *venæ comites* lying upon it. Still more internally the *pronator radii teres* is divided with the *median nerve* between its two heads, the *brachialis anticus* beneath the *biceps* and *pronator teres*, the *palmaris longus*, the *flexor sublimis*, and the *flexor carpi ulnaris*. Beneath these three muscles are divided the *anterior ulnar recurrent artery* and branches of the *anastomotica magna* and *inferior profunda arteries*.
3. Cut through the anterior ligament of the joint, then the external lateral ligament with the *extensor communis digitorum*, *extensor carpi ulnaris*, and *anconeus* lying outside

and behind this ligament and separated from it by a further portion of the supinator brevis. Cut through the internal lateral ligament with the aponeurosis of the flexor carpi ulnaris, the ulnar nerve, posterior ulnar recurrent, and branches of the anastomotica magna and inferior profunda arteries.

4. Cut through the posterior ligament, the tendon of the triceps with the subanconeus beneath it, behind the external condyle the nerve to the anconeus, with the posterior articular artery, the posterior interosseous recurrent, and the terminal branch of the superior profunda arteries.

AMPUTATION THROUGH THE FOREARM.

FLAP OPERATION.

Steps of the Operation.

1. An assistant holds the arm at right angles to the trunk, and the forearm completely supinated. Stand inside the right arm. (In this description it is supposed that the bones are to be divided in their centre.) Define the level of both bones, and indicating their position with the thumb and index finger, introduce the point of the knife a little below the point of intended division of bone, and direct it so that it may pass over the anterior surface of both bones. See Fig. 20 and Fig. 21. Cut a flap about three inches long. In doing this you divide in order the *flexor carpi ulnaris*, the *flexor profundus digitorum*, the *flexor longus pollicis*, the *supinator longus*, and the lower limit of the *pronator radii teres*. On the *flexor profundus* and *flexor longus pollicis* are divided from within outwards the *flexor sublimis*, the *palmaris longus*, and the *flexor carpi radialis*; between the *flexor carpi ulnaris* and the *flexor sublimis*

digitorum, the *ulnar artery and venæ comites*, and to its inner side the *ulnar nerve with its dorsal branch*; the *radial*

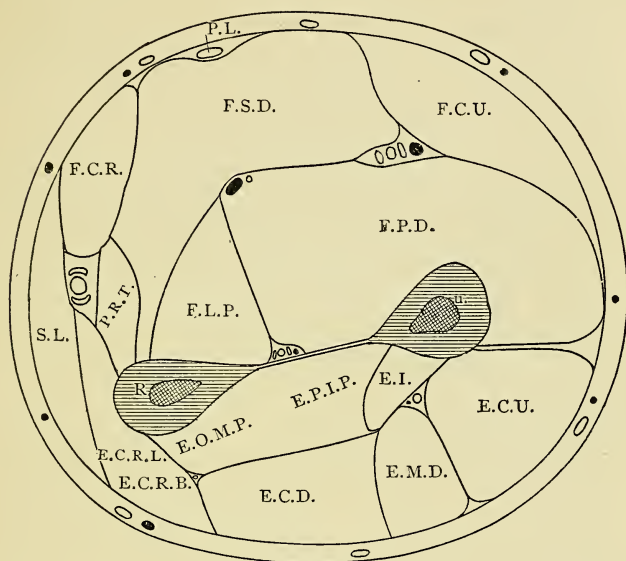


Fig. 21 is a transverse section through the centre of the right forearm.

The radial artery, nerve and *venæ comites* lie between the supinator longus, pronator radii teres, and the flexor carpi radialis; the median nerve with the *comes nervi mediani* between the flexor sublimis and flexor profundus digitorum; the ulnar vessels and nerve between the flexor sublimis digitorum, the flexor profundus digitorum, and the flexor carpi ulnaris; the anterior interosseous vessels and nerve upon the membrane and between the flexor longus pollicis and the flexor profundus digitorum; the posterior interosseous vessels and nerve between the extensor indicis, the extensor minimi digiti, and the extensor carpi ulnaris.

artery on the flexor longus pollicis, between the flexor carpi radialis and supinator longus, and the *radial nerve* as it passes backwards beneath the tendon of the supinator

longus. The *median nerve* and *comes nervi mediani* are divided as they lie beneath the *flexor sublimis digitorum*.

Outside the muscles you divide the *deep fascia* and the *superficial fascia*, containing internally the *internal cutaneous nerve* and *ulnar vein*, externally the *external cutaneous nerve* and *radial vein*, and in the middle line the *median vein*.

2. The assistant now forcibly flexes the arm. Commencing and ending at the angles of the anterior incision, shape a flap on the posterior surface of the forearm about two-thirds the length of the anterior one, cutting through the skin and superficial fascia. In the *fascia* you divide from without inwards posterior branches of the *external cutaneous*, the *radial nerve* as it perforates deep fascia, the *lower external cutaneous of the musculo-spiral*, and the posterior branches of the *internal cutaneous nerves*.
3. Raise the skin and superficial fascia to the level of the base of the anterior flap, and then cut through the muscles and soft structures on the back of the forearm to the bones and interosseous membrane. They are in order from without inwards the *extensor carpi radialis longior* and *brevior*, the *extensor communis digitorum*, and *extensor carpi ulnaris*: beneath these the *pronator radii teres*, the *supinator brevis*, the *extensor ossis metacarpi pollicis*, and the *extensor secundi internodii pollicis*. The *posterior interosseous nerve* and *artery* are divided on the *extensor ossis metacarpi pollicis*.

Internal to the ulna by the same incision are divided part of the *aponeurosis* of the *flexor carpi ulnaris* and the subjacent *flexor profundus digitorum*. Binding down these muscles and sending in *septa* between them is divided the *deep fascia*.

4. Cut through that portion of the *flexor longus pollicis* and *flexor profundus digitorum* left on the interosseous mem-

brane, with the anterior interosseous artery and nerve between them, dividing the membrane and periosteum.

5. Raise the soft structures off the bones, turning back the periosteum for half an inch, and saw through the radius and ulna.

CIRCULAR METHOD.

Steps of the Operation.

1. The arm is held at a right angle to the trunk by an assistant. Stand behind the arm, and make a circular incision through the skin and superficial fascia at a point three inches below the intended section of the bones.
2. The assistant retracting the skin and superficial fascia, cut through the muscles and structures down to the bone, at a distance of about an inch and a half from the first incision.
3. Separate the muscles from the bones for another inch, then cut through the periosteum, and expose the bones half an inch above the point of periosteal section, and saw through them transversely.

I will not give the structures cut through in this case, as their relations are already fully described in the flap operation. See Fig. 21.

AMPUTATION THROUGH THE WRIST JOINT.

CIRCULAR METHOD.

Steps of the Operation.

1. The skin covering the wrist is dragged forcibly upwards by an assistant, who encircles the lower part of the forearm with his hand. Make a circular incision through the skin and superficial level on a level with the pisiform bone.

In the *superficial fascia* you divide on the back of the wrist internally the posterior division of the *ulnar nerve*, externally the *radial nerve*, and on the anterior surface internally the cutaneous branches of the *ulnar* and *internal cutaneous nerves*, externally the terminal branches of the *external cutaneous* and the *palmar cutaneous* of the *median*. Small branches of the *radial*, *ulnar*, and *median veins* are also divided.

2. Reflect the skin and superficial fascia to the level of a line joining the extremities of the styloid processes of the radius and ulna. Then by another circular incision divide the deep fascia on the front of the arm, the posterior annular ligament separating the tendons, and its fibrous septa on the posterior aspect.

On the posterior surface you divide from without inwards the tendons of the *extensor ossis metacarpi* and *primi internodii pollicis*, surrounded by a single *synovial sheath*, the *extensor carpi radialis longior* and *brevior* in a *synovial sheath*, the *extensor secundi internodii pollicis*, the *extensor communis digitorum* and *indicis*, the *extensor minimi digiti*, and the *extensor carpi ulnaris*. The *posterior interosseous nerve* is divided beneath the tendon of the *extensor communis digitorum*, branches of the *anterior interosseous artery* are cut through external to these tendons, and branches of the *posterior interosseous* internal to them. On the anterior surface of the arm you divide from without inwards, the tendon of the *flexor carpi radialis*, beneath it the *flexor longus pollicis* surrounded by *synovial membrane*, and internal to these the *palmaris longus* and *flexor sublimis*. The tendons of the *flexor sublimis* are arranged in two levels, the anterior pair being those of the middle and ring fingers, the posterior being those of the index and little finger. Beneath the *flexor sublimis*

and palmaris longus are the tendons of the *flexor profundus digitorum*, arranged on the same level, that going to the index finger being alone distinct, the others being connected by areolar tissue. A *synovial* covering surrounds the tendons of the flexor sublimis and profundus in a single sheath. Most internally the tendon of the *flexor carpi ulnaris* is divided. The *radial artery* with the *superficialis volæ* and *venæ comites* are divided as they leave the anterior margin of the lower end of the radius, the *ulnar artery*, its *venæ comites* with the *ulnar nerve* internal to it are cut through just outside the tendon of the flexor carpi ulnaris. The anterior branch of the *anterior interosseous artery* is divided beneath the tendons of the flexor profundus digitorum.

3. Cut through the dorsal, internal and external lateral and anterior ligaments of the radio-carpal articulation, exposing the under surface of the fibro-cartilage. Saw through the extremities of both styloid processes.

AMPUTATION AT WRIST JOINT.

FLAP OPERATION.

Steps of the Operation.

1. An assistant holding the hand in a prone position, make across the back of the wrist a semilunar incision through the skin and superficial fascia with its convexity downwards, extending from a point just below the styloid process of the radius to one just below the styloid process of the ulna. Reflect the skin and superficial fascia to the level of the joint, and cut through the tendons and ligaments on the back of the joint. I have already given

in the last operation the structures cut through in detail, so will not describe them a second time. See Fig. 22.

2. Now cut a large semicircular flap from the skin and superficial fascia of the palm, commencing and ending your incision as before.

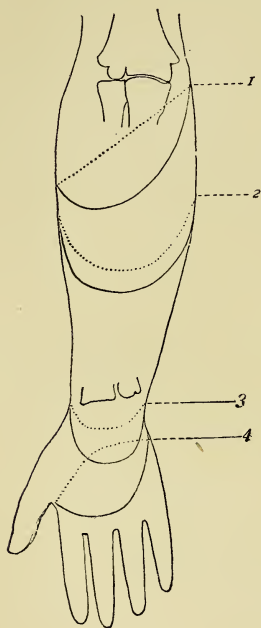


Fig. 22.

3 indicates the incisions in the flap amputation at the wrist joint.

The dotted line represents the posterior and the continuous line the anterior incision.

You divide in so doing from within outwards terminal branches of the *internal cutaneous*, *palmar cutaneous* branches of the *ulnar* and *median nerves*, and the terminal branches of the *external cutaneous* nerve. Also small veins, with branches of the *superficial volæ* and *ulnar arteries*.

3. Reflect this flap from the deep fascia and annular ligament to the level of the radio-carpal articulation, dividing the origin of the *palmaris brevis* from the annular ligament, cutting the *ulnar artery*, *venæ comites*, and *ulnar nerve* as they lie on the annular ligament, and reflecting them in the flap with branches of the *superficialis volæ*.

4. Then cut transversely through deep fascia and the struc-

tures intervening between it and the radio-carpal articulation. (These have been described in order in the *Circular Amputation*.) Divide the anterior and lateral ligaments of

the joint, and saw off the extremities of the styloid processes. The deeper structures are usually included in the anterior flap, but unnecessarily.

AMPUTATION OF THE THUMB AT THE CARPO-METACARPAL ARTICULATION.

OVAL METHOD.

Steps of the Operation.

1. Define accurately the articulation between the metacarpal bone and trapezium, and the position of the radial artery.
2. Grasp the thumb with the left hand, while an assistant holds the hand in a prone position. Enter the point of your knife between the outer side of the base of the metacarpal bone and the styloid process of the radius, carefully avoiding the radial artery and its *venæ comites*. Cut from this point along the trapezium and the outer border of the dorsal aspect of the metacarpal bone till you reach its centre.
3. Continue your incision obliquely forwards and to the radial side of the thumb till you reach the level of the web between the thumb and index finger, then continue it across the front of the metacarpal bone till you reach the web, when you direct it obliquely upwards and outwards to reach the end of the vertical incision in the centre of the metacarpal bone. In the whole extent of this incision cut through everything till you reach bone. In so doing you will divide *skin, superficial fascia* containing branches of the *external cutaneous* and *radial nerves*; *deep fascia*, and in front the *outer division* of the *palmar fascia*, the tendon of the *extensor ossis metacarpi* and the *extensor primi inter-nodii pollicis*, both being probably split longitudinally, the

latter being then divided, the *extensor secundi internodii pollicis*, the *abductor pollicis*, the outer head of the *flexor brevis pollicis* and the slip from the deep head just above the sesamoid bones (it must be remembered that the lower end of the head of the metacarpal bone projects slightly beyond the limit of the web). You also cut through the tendon of the *flexor longus pollicis* with its *synovial* sheath, and the deep head of the *flexor brevis pollicis* with the *adductor pollicis* just above the internal sesamoid bone. On either side of the tendon of the *flexor longus pollicis* are divided the branches of the *princeps pollicis* and the *median nerve*, and posteriorly the two branches of the *dorsalis pollicis*.

4. Turn back the skin, superficial fascia, and subjacent structures from the first metacarpal bone, avoiding the radial artery, as it lies on the ulnar aspect of its base.

In doing this you divide the insertion of the *opponens pollicis* into the radial side of the metacarpal bone, the origin of the *abductor indicis* from its ulnar side, the insertion of the *extensor ossis metacarpi pollicis* into its base, the *lateral ligaments* and the *capsular ligament* binding the metacarpal bone to the trapezium. It must be remembered in disarticulating that the articulating surfaces of the trapezium and metacarpal bones are saddle-shaped, so that it is by no means easy to get the point of the knife between them.

AMPUTATION OF THUMB THROUGH THE CARPO-METACARPAL ARTICULATION.

FLAP METHOD.

Steps of the Operation.

1. An assistant holds the hand in a supine position. Define the position of the carpo-metacarpal articulation. Hold

the thumb slightly extended and adducted on the palm. Enter the point of a long narrow knife in the centre of the web, in the groove between the adductor pollicis and the abductor indicis, and pass it upwards and inwards till it perforates the palm in front of the articulation of the metacarpal bone with the trapezium.

2. Now cut outwards, keeping the blade of the knife close to the anterior surface of the metacarpal bone till you reach the prominence caused by the head of this bone and the sesamoid bones, where you alter the direction of the blade, cutting towards the palmar surface. In this incision you divide the *adductor pollicis*, above it the *deep* head of the *flexor brevis pollicis*, the tendon of the *flexor longus pollicis* with its *synovial* sheath, the *slip* of the *deep* head of the *flexor brevis pollicis* that passes to join the superficial head, the *superficial* head, the *opponens*, and superficial to it the *abductor pollicis*. The *outer* division of the *palmar fascia* is divided superficially to these, with the *superficial fascia* containing the *digital* branches of the *median nerve* to the thumb, and terminal branches of the *external cutaneous nerves* and branches of the *superficialis volæ*. The *princeps pollicis* is probably divided beneath the tendon of the long flexor of the thumb.
3. The hand being now supinated, join the extremities of this incision by an incision which is slightly convex downwards and outwards. In so doing you divide *skin*, *superficial fascia* containing branches of the *external cutaneous* and *radial nerves* and branches of *veins*, *deep fascia*, the tendons of the *extensor ossis*, the *extensor primi*, at a little distance the *extensor secundi internodii pollicis*, and lastly the *abductor indicis*. The *dorsalis indicis* is divided on the ulnar side of the metacarpal bone.
4. Cut through the lateral and capsular ligaments connecting

the trapezium and metacarpal bone, carefully avoiding the radial artery, as it lies on the ulnar side of the base of the metacarpal bone.

OPERATION FOR THE REMOVAL OF THE FOUR INNER METACARPAL BONES.

Steps of the Operation.

1. An assistant retains the hand in a supinated position with the thumb forcibly abducted. Define the position of the unciform process. Enter the point of a narrow knife just below this process and on a level of the anterior surface of the base of the fifth metacarpal bone, and pass the point in between the bones and soft structures to the angle of junction of the inner border of the thumb and the outer border of the palm, so that the point may then emerge in the groove between the abductor indicis and adductor pollicis. See Fig. 23.
2. Carry the blade downwards, keeping close to the anterior surface of the metacarpal bones, and then turning the edge forwards cut a large palmar flap.

In making this flap you divide from within outwards the *abductor minimi digiti*, the *flexor brevis minimi digiti*, beneath it the *opponens minimi digiti*, and between these two last muscles and the abductor the deep division of the ulnar nerve and artery. Covering these muscles you cut the inner division of the palmar fascia. Outside these you divide the tendons of the *flexor profundus* and *sublimis digitorum*, covered at the point of section by the upper extremity of the vaginal sheaths, the *lumbricales* tendons, and the nerves to the inner two lumbricals from the deep division of the ulnar.

The *digital arteries* are divided with the terminations of the *interosseous arteries* from the deep arch; also the *digital branches* of the *median* and *ulnar nerves*. The knife perforates and divides the *adductor pollicis*, and probably passes in front of the *radialis indicis* artery and the *abductor indicis*. More superficially are divided the four processes of the *middle division* of the *palmar fascia*, the *superficial transverse ligament*, *superficial fascia*, and *skin*.

3. An assistant pronating the hand, make a semilunar incision with its convexity upwards, joining the extremities of the anterior incision. This incision will divide the *skin* and *superficial fascia* half an inch below the *carpo-metacarpal articulations*. In the *superficial fascia* are divided from within outwards branches of the *internal cutaneous*, *ulnar*, *lower external cutaneous* of *musculo-spiral* and *radial nerves*, with branches of *veins* and *arteries*.

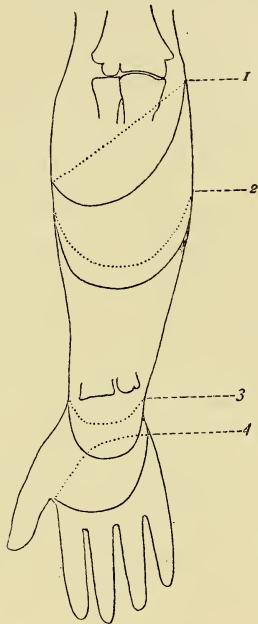


Fig. 23. No. 4 shows the incisions made in the operation for removal of the four inner metacarpal bones, the dotted line indicating the posterior, and the continuous line the anterior incision.

4. Reflect the *skin* and *superficial fascia* to the level of the articulation, and divide from within outwards the tendons of the *flexor carpi ulnaris* at its insertion into the base of

the fifth metacarpal, the *extensor minimi digiti*, the *extensor communis* and *indicis*, the *extensor carpi radialis brevis* at its insertion into the radial side of the base of the middle finger, and the *extensor carpi radialis longior* into the radial side of the index finger, avoiding the radial artery and veins which lie on its outer margin. The *metacarpal* artery and three interosseous branches of the *posterior carpal arch* are also divided.

5. Now cut through the dorsal ligaments of these joints, and cut obliquely through the portion of the abductor indicis separating the anterior and posterior incisions. On its posterior surface the *dorsalis indicis* is divided, and the *radialis indicis* upon its anterior surface.
6. The joints having now been opened, cut through the anterior ligaments flexing and raising the bases of the metacarpal bones so as to enable you to keep close to their anterior surfaces. You cut away the small part of the flexor brevis pollicis which arises from the base of the second and third metacarpal bones, and the radial artery after it has given off the princeps pollicis. Also the tendon of the flexor carpi radialis from the base of the second metacarpal bone, and the flexor carpi ulnaris from the base of the fifth.

REMOVAL OF FINGER AT METACARPO-PHALANGEAL ARTICULATION.

OVAL OPERATION.

Steps of the Operation.

1. Enter the point of your knife in the skin covering the metacarpal bone half an inch behind the head of that bone. From this point make a median incision down to the bone for half an inch.

2. Now pass obliquely to your right, making for the centre of the cleft between this and the adjoining finger, and continue this incision from this point transversely across the anterior surface of the finger along a transverse furrow seen here. Having arrived at the centre of the web on the left side of the finger, cut obliquely upwards to the lower extremity of the short vertical incision. This incision should extend down to bone in the whole of its extent. In making it you divide *skin, superficial fascia* with the *digital nerve, artery, and veins* on either side, on the posterior surface beneath these the *extensor tendon* first vertically and then obliquely, with the tendon of the *lumbrical* going to join it on one side and the aponeurotic insertion of the *interossei*. On the anterior surface you also divide the two processes of the *palmar fascia*, the *vaginal sheath*, and the tendons of the *superficial and deep flexor muscles* surrounded by *synovial* membrane.
3. Divide the lateral ligaments and the thick anterior ligament of the joint, and cut through on either side the insertions of the *interossei* into the base of the phalanx.
4. Should it be desired to remove the head of the bone, the vertical incision can be extended upwards for a short distance, the soft structures separated from the bone, and its head removed obliquely with bone forceps.

AMPUTATION THROUGH METACARPO-PHALANGEAL ARTICULATION.

FLAP OPERATION.

The finger may be removed by making two flaps.

You commence your incision as before, but on arriving at the web, instead of cutting transversely across the

front of the phalanx, you continue your incision to the anterior surface of the hand, opposite to the point at which you commenced, making a second flap on the other side.

You then cut through the soft structures, and remove the first phalanx. As they are the same as those already enumerated in the previous operation, I will not describe them again.

AMPUTATION OF THE LITTLE FINGER AT THE CARPO-METACARPAL ARTICULATION.

THE OVAL METHOD OF OPERATION.

Steps of the Operation.

1. An assistant holds the hand pronated. Make an incision from a point midway between the inner side of the base of the fifth metacarpal bone and the tip of the styloid process, along the inner margin of the dorsal aspect of the fifth metacarpal bone, till you reach the head of the bone.
2. You then continue the incision obliquely to the centre of the web between the fourth and fifth fingers, then transversely inwards across the anterior surface of the phalanx, and then obliquely upwards and outwards to the lower termination of the vertical incision. Cut down to bone in the whole length of this incision. In performing this part of the operation, you divide *skin*, *superficial fascia* containing small *veins*, the *digital* branches of the *posterior carpal arch* to the sides of this finger, *digital* branches of the *ulnar nerve* on the palmar aspect, and of the *dorsal* branch of the *ulnar* on the dorsal aspect. The *posterior carpal* branch of the *ulnar artery* may itself be divided at the upper limit of the incision.

You also cut through the two processes of the inner slip of the *middle* division of *palmar fascia*; the *inner* division of *palmar fascia* covering the muscles of the little finger; the *vaginal sheath*, containing the tendons of the *flexor sublimis* and *profundus digitorum*, covered by *synovial membrane*, and on the back of the finger the *extensor minimi digiti* fused with the tendon of the *long extensor of the fingers*. Laterally joining the expansion of the *extensor* tendons the tendon of the *lumbrical* and the expansion of third *palmar interosseous muscle* are divided.

3. Turn back the skin, superficial fascia, and muscles from the metacarpal bone, clearing it in the whole of its length, and divide the ligaments connecting it with the unciform and fourth metacarpal bones.

In doing this you divide the *deep transverse ligament*, the insertion of the third *palmar interosseous* into the radial side of the base of the first phalanx, the *flexor brevis minimi digiti* at its insertion into the ulnar side of the base of the same phalanx, the *opponens minimi digiti* from the whole length of the ulnar side of the fifth metacarpal bone, the first *palmar interosseous* from its origin from the radial side of the same bone, the tendons of the *extensor carpi ulnaris* and *flexor carpi ulnaris* from their insertions into the posterior and anterior surfaces respectively of the base of the fifth metacarpal bone, and the *dorsal, palmar, and interosseous ligaments* binding the fifth metacarpal to the unciform and fourth metacarpal bones.

AMPUTATION OF FINGER AT INTER-PHALANGEAL ARTICULATION.

FLAP OPERATION.

Steps of the Operation.

1. First define carefully the limit of the base of the distal phalanx, and flex it slightly. Open the joint on its upper surface by a transverse incision, cutting through the dorsal expansion of the extensor tendon, and lateral ligaments. Then flex the joint still further, and divide the anterior ligament of the joint.
2. Change the direction of the knife, first cutting downwards along the palmar surface of the phalanx to be removed, and then cut to the anterior surface of the finger, in this way making a sufficiently long palmar flap. In this operation you divide *skin, superficial fascia*, containing on the back of the finger the *dorsal branches of the digital nerves and arteries*, and the digital branches of the *dorsal division of the ulnar and radial nerves*, on the front of the finger the *digital arteries and nerves*, the *extensor tendon*, the *synovial membrane of the joint*, the *lateral ligaments*, the *anterior ligament*, the tendon of the *flexor profundus digitorum*, and in the case of the amputation between the first and second phalanges, the *flexor sublimis tendon* also, both tendons being surrounded by *synovial membrane* and the *vaginal sheath*.

CIRCULAR METHOD.

The phalanges may be amputated through the interphalangeal articulation by a circular incision. This is useful when

there is not enough material left to make the ordinary palmar flap.

Steps of Operation.

1. Grasp the phalanx to be removed, and make a circular incision through the skin and superficial fascia. In amputation of the last phalanx, the level of this incision should be a little more than half an inch below the articulation, while in the case of the second phalanx the flap need not be so long.
2. Reflect the skin and superficial fascia to the level of the articulation, and cut through the same structures as enumerated in the flap operation, except that, in this case, that portion of the vaginal sheath formed by the ligamentum cruciatum is cut through instead of the arch of transverse fibres.

SECTION III.—EXCISIONS OF BONES.

EXCISION OF THE SUPERIOR MAXILLARY BONE.

I WILL describe two different incisions by which the jaw may be exposed.

Steps of the Operation.

1. Commencing at the inner canthus of the orbit, make an incision down to the bone, along the margin of the ala of the nose to the nostril, then inwards to the septum nasi, and then vertically downwards through the middle of the upper lip. See Fig. 24.

In so doing, you divide *skin, superficial fascia*, some fibres of the *orbicularis palpebrarum*, the *compressor naris*, with the *levator labii superioris* lying on it, the *depressor alæ nasi*, and the *orbicularis oris*. Beneath the *orbicularis oris* you divide *submucous tissue, buccal glands, and mucous membrane*. Branches of the *infratrochlear nerve, nasal and labial branches of the infraorbital nerve and artery*, and small branches of the *facial nerve* are cut through. The *angular artery and vein* are divided at the inner canthus. Lower down the *lateral nasal artery* is divided beneath the common elevator of the lip and nose, and in the middle line the *coronary artery* of the upper lip is cut as it lies between the mucous membrane and the *orbicularis oris*, and its branch the *artery to the septum*.

2. Now separate the soft structures from the front of the superior maxillary bone by dividing the *mucous membrane*

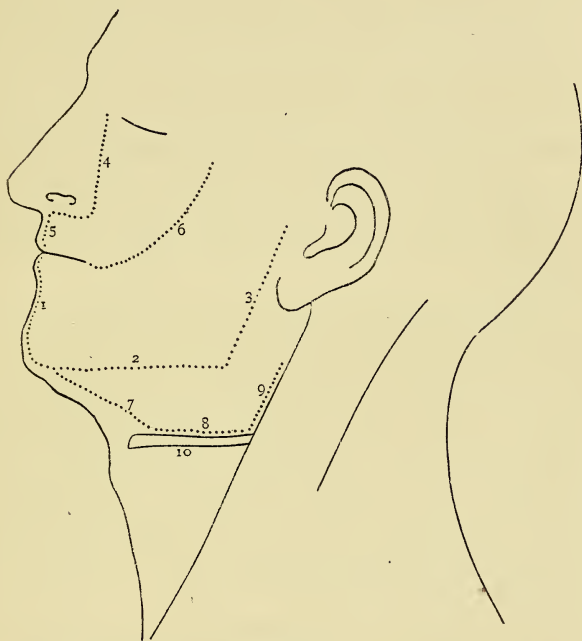


Fig. 24.

4 and 5 indicate the lines of the incisions in the usual operation for the removal of the upper jaw, and 6, that in which the cheek is raised upwards from the bone as a large convex flap.

1, 2, and 3 show the incisions necessary for the removal of the left half of the lower jaw.

at its reflection from the lip, and by cutting away in order from the superior maxilla the *incisive* fibres of the *orbicularis*, the *depressor alæ nasi* from the superior incisive

fossa, the *compressor naris* from the canine fossa, the *levator anguli oris* from the canine fossa immediately below the infraorbital foramen, the *buccinator* from the alveolus corresponding to the three molar teeth, the *infraorbital nerve* and *artery* as they emerge from the infraorbital foramen, the *levator labii superioris alaeque nasi* from the nasal process of the superior maxillary bone, the *levator labii superioris proprius* where it arises from the superior maxilla above the infraorbital foramen and from the malar bone, and the *zygomaticus minor* from the anterior inferior part of the malar bone. Some *alveolar branches* of the *internal maxillary artery* are cut above the origin of the *buccinator*.

In the other operation an incision, which is convex downwards and outwards, is made from the angle of the mouth upwards and outwards as far as the temporal fossa. See No. 6, Fig. 24. The cheek is cut through to the anterior margin of the masseter, and the flap is reflected upwards on to the forehead, the soft parts being raised from the bone as already described. The *zygomaticus major* is also removed from its bony origin, and the malar branches of the temporo-malar nerve are divided as they emerge from the malar bone.

3. Divide the periosteum covering the anterior surface of the superior maxilla immediately below the orbital margin, and raise it from the bone. Separate the palpebral ligament and orbital periosteum from the lower margin and floor of the orbit. With a pair of cutting forceps cut through the lower and outer angle of the orbit till you reach the sphenomaxillary fissure, dividing in so doing the periosteum on the anterior and posterior surfaces of the malar and maxillary bones, the *malar process* of the *superior maxilla*, the *malar bone*, and part of its orbital

plate. The anterior limit of the masseter may be divided at its origin.

4. Cut away the ala of the nose from the free margin of the superior maxilla, dividing fibrous tissue, the lateral cartilage of the nose at its attachment to the bone, the

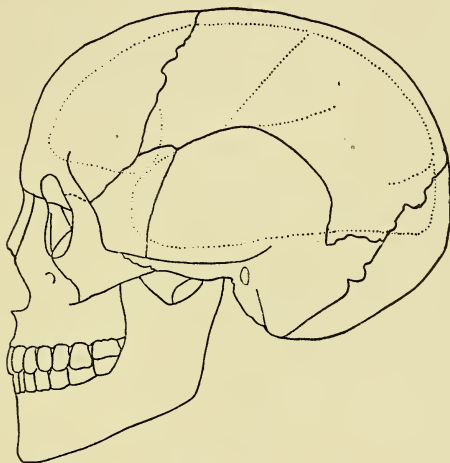


Fig. 25 (after Thane) is a diagram of the skull and lower jaw.

nasal mucous membrane, and small branches of nerves and arteries.

5. Introduce one blade of bone-cutting forceps into the nose and the other into the lower and inner angle of the orbit, having previously separated more completely the palpebral membrane and periosteum of the orbit from its floor with the origin of the inferior oblique. See Fig. 25. Cut through the intervening structures. You divide the *nasal process* of the *superior maxilla*, the *lachrymal bone and sac*, the *os planum* of the *ethmoid*, the *nasal mucous membrane*,

with branches of the *olfactory nerve* and *nasal branches* of the *spheno-palatine ganglion* and *descending palatine artery*.

In some surgical works it is suggested that the orbital plate of the superior maxilla be divided behind the lower margin of the orbit, and in others that the section of the nasal process of the superior maxilla be continued backwards and outwards through the orbital plate of the superior maxilla into the spheno-maxillary fissure. In either case the object of the proceeding does not seem quite obvious.

6. Extract the central incisor on this side, and divide with a long-bladed knife the mucous membrane and periosteum covering the floor of the nose immediately external to the septum nasi. Divide with a hand-saw the palate processes of the palate and superior maxilla, and the alveolus of the last-named bone along this line. As you saw through the palate and alveolus you divide the muco-periosteum lining its under surface, and in it branches of the descending naso-palatine nerves and arteries.
7. Grasp the superior maxilla with lion forceps, and as you turn the jaw outwards cut away the soft palate from its attachment to the posterior margin of the hard palate, dividing from before backwards mucous membrane, submucous tissue with a few fibres of the palato-glossus, the aponeurosis of the tensor palati, some fibres of the anterior layer of the palato-pharyngeus, a portion of the levator palati, some fibres of the posterior layer of the palato-pharyngeus, submucous tissue, and mucous membrane. In front of the tensor palati branches of the descending palatine arteries and nerve and of the ascending palatine artery are cut through, and behind the aponeurosis with the levator palati twigs of the palate branch of the ascending pharyngeal artery.

8. Now wrench the superior maxilla and the greater portion of the palate bone still further from their connections, dividing further branches of the *descending palatine nerves and artery*, the *infraorbital nerve and artery* as they enter the infraorbital foramen, *alveolar branches of the internal maxillary artery* and of the *superior maxillary nerve*, and the portion of the *internal pterygoid* which arises from the tuberosity of the superior maxilla. The *vertical* portion of the *palate bone* and its *sphenoidal process* are broken in the removal of the superior maxilla.

EXCISION OF ONE HALF OF THE LOWER JAW.

Steps of the Operation.

1. Make a horizontal incision from the symphysis along the lower margin of the body of the jaw to its angle, cutting down at once to bone. In doing so you divide *skin*, *superficial fascia*, *deep fascia*, that part of the *platysma* that passes over the jaw, the *facial artery and vein* at the anterior margin of the masseter. Ligature both cut ends of these vessels. At the symphysis branches of the *submental artery* are divided as they pass over the jaw on to the face. See Fig. 24.
2. Make a vertical median incision from the centre of the lower lip to the anterior limit of the horizontal incision, dividing in so doing *skin*, *superficial fascia*, *orbicularis oris*, *depressor labii inferioris*, *submucous tissue*, *buccal glands*, and *mucous membrane*. The *inferior coronary artery* is divided between the orbicularis and the mucous membrane. Below it in the superficial fascia are cut branches of the *inferior labial*, *mental*, and *submental arteries*, and of the *mental nerve*.

3. Make an incision from the zygoma along the posterior margin of the ramus of the jaw to its angle. In making this incision you only cut through the *skin* and *superficial fascia* with small branches of the *great auricular nerve*.
4. Now raise this flap from below upwards, cutting from the jaw in order from before backwards the *levator menti* from the *incisive* pit, the *depressor labii inferioris* from its oblique origin, the small fasciculus of the *orbicularis oris* which arises just outside the *levator menti*, the *mental nerve* and *artery* as they emerge from the mental foramen, the *triangularis oris* from the oblique line, the reflection of the *mucous membrane*, and further back the *buccinator* covered by *buccal fascia*. Raise the *masseter* from its insertion into the lower half of the outer surface of the ramus, dividing the junction of the *masseteric* and *parotidean fasciæ*, and the *masseteric nerve* and *artery* may be avoided or divided as they pass outwards over the *coronoid notch*.
5. Hook the flap well up, and divide the external lateral ligament of the temporo-maxillary articulation.
6. Extract a central incisor on this side, and saw through the jaw in the middle line, dividing also the mucous membrane covering the jaw. See Fig. 25.
7. Cut from the lower margin of the body of the jaw the attachment of the platysma and deep fascia to it, and grasping the half of the divided jaw, turn off with an elevator everything that is attached to its inner surface. In so doing, you separate the origins of the *genio-hyoglossus* and *genio-hyoid* muscles of this side from the genial tubercles, unless these be avoided by making the section of the jaw a little to one side; the *anterior belly* of the *digastric* from its oval facet, the *mylo-hyoid* muscle from the mylo-hyoid ridge, and the origin of the *superior constrictor* and the *pterygo-maxillary ligament* from the jaw just below and

behind the third molar tooth. Divide the *mucous membrane* where it is reflected on to the inner aspect of the jaw from the floor of the mouth. The *lingual nerve*, its *accompanying artery*, and the *mylo-hyoid nerve and artery* can be pushed aside.

Separate the *internal pterygoid* from its insertion into the lower half of the inner surface of the ramus, and the *stylo-maxillary ligament* from the angle. Divide the tendon of the *temporal* at its insertion into the coronoid process, the *inferior dental nerve and artery* as they enter their foramen, and the *internal lateral ligament* at its attachment to the sharp inner margin of the foramen.

8. Now turn the front of the jaw still further outwards, and divide the external pterygoid at its insertion into the front of the neck of the jaw, then keeping the edge of the knife close to the jaw, divide the attachment of the capsule to it. The internal maxillary artery and vein, which lie immediately inside the neck of the jaw, must be carefully avoided.

EXCISION OF THE CLAVICLE.

Steps of the Operation.

1. The patient being placed on the back, make an incision along the length of the clavicle from its inner to its outer extremity. Make at the extremities of this incision transverse incisions sufficiently long to allow of the reflection of the skin and subcutaneous tissue from the bone.

In doing this you divide skin, superficial fascia, platysma, suprasternal, clavicular, and acromial nerves, branches of the suprascapular and acromio-thoracic arteries, and about the centre of the bone a communication between the cephalic and external jugular veins. On reflecting the

flaps you expose deep fascia covering the pectoralis major and deltoid below the clavicle, above the clavicle covering the sterno-mastoid and trapezius, and between these the lower part of the subclavian triangle. The inner head of the sterno-mastoid is seen to cross in front of the sterno-clavicular articulation, and the anterior sterno-clavicular and the interclavicular ligaments are seen in part. Externally the superior acromio-clavicular ligament is seen to cover in that articulation above.

2. Divide deep fascia over the pectoralis major and deltoid where they are attached to the clavicle, exposing these muscles, and carefully dividing them at their origin from the clavicle.
3. The layer of deep fascia beneath the pectoralis major is exposed, and it is seen to be attached to the clavicle behind this muscle. Cut this through and expose immediately beneath it the anterior layer of the costo-coracoid membrane. Branches of the acromio-thoracic and superior thoracic arteries may be divided in this stage of the operation.
4. Divide deep cervical fascia at its attachment to the clavicle, the clavicular origins of the sterno-mastoid and trapezius, and the layer of deep fascia beneath them, carefully avoiding any injury to subjacent structures. Do not forget the anterior jugular vein, which lies beneath the former muscle.
5. Cut through the superior and inferior acromio-clavicular ligaments and the interarticular fibro-cartilage, if it is present, as it usually is.
6. Grasp the outer end of the clavicle with bone forceps, raising it, and at the same time rotating it a little, so that its anterior surface is directed somewhat upwards. Now divide at their attachment to the clavicle the trapezoid and

conoid ligaments; the anterior layer of the costo-coracoid membrane, where it is attached to the clavicle in front of the origin of the subclavius; the subclavius, and behind it the posterior layer of the costo-coracoid membrane, avoiding any injury to the subclavian vessels which lie beneath it, or to the suprascapular artery and vein which lie immediately above it. The nerve to the subclavius need not be cut through.

7. Now draw the outer end of the clavicle downwards, at the same time rotating it so that the anterior surface looks somewhat downwards. Separate the suprascapular artery and vein from their connection with the clavicle, and divide the fascia which binds the omo-hyoid to the clavicle. In some cases the suprascapular artery arises from the third part of the subclavian artery, but this is very exceptional.
8. Again raising the outer end of the clavicle, using its inner end as the fulcrum, cut through the rhomboid ligament, carefully avoiding the innominate vein, which lies directly behind it.
9. Divide the anterior sterno-clavicular ligament, the inter-clavicular ligament, and the interarticular fibro-cartilage.
10. Forcibly rotate the bone so as to enable you to cut through the posterior sterno-clavicular ligament, and the sterno-hyoid muscle where it arises from the clavicle. In doing this, avoid any injury to the anterior jugular vein, which lies in the immediate vicinity.

The sternal head of the sterno-mastoid need not be divided.

Branches to the bone from the suprascapular and acromio-thoracic arteries will be divided in removing it.

EXCISION OF THE SCAPULA.

Steps of the Operation.

1. The patient is placed in a semi-prone position. An assistant should have as his sole duty the control of the subclavian artery, either through the skin, or more thoroughly by means of an incision made through the skin and fascia superficial to the artery.
2. Define the position of the inner and lower angle of the scapula, and the tip of the acromion process. Make an incision from about the centre of the upper border of the scapula to the lower angle of the bone. Make two others, one from the upper extremity of this incision to the inner angle of the scapula, and another outwards from the same point to the anterior extremity of the acromion. You divide skin and superficial fascia, branches of the supra-acromial nerves, and of the posterior and lateral branches of the upper dorsal nerves.

Reflect the skin and superficial fascia, and expose the whole scapular area.

3. Cut through deep fascia and the trapezius at their attachment to the spine and to the acromion, with branches of the superficial cervical and suprascapular arteries beneath it and in its substance. Cut through the deltoid and the deep fascia covering it at their attachment to the lower border of the spine and acromion, dividing in and beneath the muscle branches of the acromio-thoracic artery.
4. Raise the trapezius from the scapula, dividing a layer of cervical fascia beneath it, while an assistant pulls the scapula downwards. Now define the upper border of

the scapula, divide the omo-hyoid, and expose the suprascapular artery as it passes over the notch. Ligature it just before it gives off its subscapular branch. Expose the suprascapular nerve and divide it.

5. Divide the levator anguli scapulæ at its insertion into the inner border of the scapula with branches of the superficial cervical upon its surface, the posterior scapular artery and possibly the nerve to the rhomboid muscles beneath it. Ligature the artery.

Cut through the rhomboideus minor and major at their insertions, with small branches of the dorsalis scapulæ, subscapular, and posterior scapular arteries.

6. Divide the superior, inferior, and interarticular acromioclavicular ligaments. Turn down the deltoid, exposing the bursa beneath that muscle, and dividing branches of the posterior circumflex artery and circumflex nerve.
7. Cut through the origins of the latissimus dorsi, teres major, teres minor, and the long head of the triceps from the scapula, and the infraspinatus and supraspinatus muscles at their insertions into the great tuberosity of the humerus. In doing this you divide the inferior scapular branch of the subscapular artery between the teres major and minor muscles, the dorsalis scapulæ beneath the last muscle, and branches of the suprascapular artery and nerve, in and beneath the supraspinatus and infraspinatus. Divide the upper and back part of the capsule of the joint, the long head of the biceps with the ascending branch of the anterior circumflex artery, the coraco-humeral and gleno-humeral ligaments.
8. An assistant rotates the humerus inwards, while you grasp the spine of the scapula and draw the glenoid cavity backwards. Divide the remainder of the capsule, the bursa beneath the subscapularis, and the tendon of the subscapu-

laris muscle, avoiding carefully the axillary artery and its circumflex branches.

9. The whole scapula can now be raised. You now cut through the serratus magnus at its insertion, and expose and ligature the subscapular artery. The nerves to the subscapularis will also be cut through.

Divide the coraco-clavicular ligaments, the coraco-brachialis and short head of the biceps at their origin from, and the pectoralis minor at its insertion into the coracoid process.

EXCISION OF THE RADIUS.

Steps of the Operation.

1. An assistant holds the forearm in a semi-prone position. Define the position of the styloid process and of the head of the radius.

Make an incision from the outer surface of the head of the radius to the anterior margin of the tip of the styloid process, dividing skin and superficial fascia, containing branches of the radial vein, of the lower and upper external cutaneous of the musculo-spiral and of the external cutaneous nerve. You expose deep fascia.

2. Cut down to bone in the whole length of the skin incision. You divide the posterior margin of the supinator longus, the extensor carpi radialis longior and brevior, beneath them in the upper third of the arm the supinator brevis, and in the middle third the pronator radii teres. Still lower down the tendon of the supinator longus is divided obliquely as it passes to its insertion into the styloid process. The posterior interosseous nerve is divided in the substance of the supinator brevis, and the radial nerve as it passes backwards beneath the supinator tendon at the junc-

tion of the lower third with the upper two thirds of the forearm.

3. Separate the muscles from the front and back of the bone in the middle third of the arm, cutting from the bone in front the attachments of the pronator radii teres, flexor sublimis digitorum, flexor longus pollicis, and behind the extensor ossis metacarpi and the extensor primi internodii pollicis. Divide the interosseous membrane, and place a chain saw around the bone at its centre, and cut it through, or if you prefer it, divide it with bone forceps.
4. Raise the lower fragment from its bed, grasping it firmly with strong forceps. Divide the attachments of the flexor longus pollicis and pronator quadratus to its anterior surface. Sever the attachments of the posterior annular ligament to the ridges on the back of the radius, and separate from it the tendons of the extensor ossis metacarpi, the extensor primi internodii pollicis, the extensor carpi radialis longior and brevior, the extensor secundi internodii pollicis, the extensor communis digitorum, the extensor indicis, and the extensor minimi digiti. The posterior branch of the anterior interosseous artery is cut through in clearing this surface of the bone.
5. Levering the bone further from its bed, cut through the anterior, posterior, and external lateral ligaments of the wrist, the interarticular fibro-cartilage, and scattered fibrous tissue uniting the radius to the lower end of the ulna. Branches of the anterior interosseous artery may be cut through in front.
6. Seize the upper fragment in a similar manner, and separate from the radius the attachments of the supinator brevis, the remainder of the pronator radii teres, the oblique origin of the flexor sublimis digitorum, the interosseous membrane, the oblique ligament, dividing lastly the orbicular

ligament and setting free the remainder of the bone. Care should be taken to avoid injuring the posterior interosseous artery as it passes back between the oblique ligament and the interosseous membrane.

Suture the ends of the posterior interosseous and radial nerves together with gut sutures, and then bring the muscle and skin flaps together, inserting drainage tubes.

EXCISION OF THE FIBULA.

Steps of the Operation.

1. The knee is flexed, and an assistant holds the leg with its inner aspect resting on the table. Make an incision from the anterior margin of the head of the fibula to the tip of the external malleolus, dividing skin and superficial fascia, containing branches of the communicans peronei nerve, of the external saphenous nerve and vein, and of the external cutaneous nerve. You expose deep fascia.
2. Find the position of the intermuscular septum between the peronei and extensor longus digitorum in the middle third of the leg, and divide the deep fascia outside its attachment, avoiding carefully the musculo-cutaneous nerve. Separate the peroneus brevis from this intermuscular septum till you reach the fibula, when you separate the origins of the peronei from the middle third of the outer aspect of the fibula.
3. Divide the intermuscular septum, the extensor longus digitorum and the extensor longus pollicis at their attachments to the anterior surface of the fibula.
4. Separate the origin of the flexor longus pollicis and the intermuscular septum from the postero-internal surface of the fibula, carefully avoiding the peroneal artery, which lies under the border of this muscle.

5. Cut through the fibula about its centre with bone forceps, and grasping the lower fragment, raise it and rotate it a little, so as to enable you to separate the origin of the tibialis posticus from the surface in front of the oblique line of the fibula, and to cut through the interosseous membrane.
6. Raising the lower fragment still further, divide the deep fascia and external annular ligament attached to it posteriorly, the deep fascia and anterior annular ligament attached to it anteriorly, the lower portions of the origins of the peroneus brevis, flexor longus pollicis, tibialis posticus, extensor longus digitorum, peroneus tertius and interosseous membrane. Lastly, cut through the inferior interosseous ligament, the anterior and posterior inferior tibio-fibular ligaments, and the three divisions of the external lateral ligament of the ankle joint.

The peroneal artery will probably be cut through as it lies on the back of the inferior tibio-fibular articulation, and the anterior peroneal artery as it passes forwards above it.

7. Raise the upper fragment in a similar way. In removing this half of the bone great care must be taken to avoid dividing the anterior tibial artery and veins as they pass forwards between the tibia and fibula.

Remove the remaining origin of the peroneus longus from the outer surface of the bone, dividing the anterior tibial, recurrent articular and musculo-cutaneous nerves in the muscle. Cut through the insertion of the biceps, the long and short external lateral ligaments, and the bursa between the former and the biceps tendon.

8. Twisting the fragment forwards, separate the origins of the soleus from the postero-internal surface and head of fibula, the remainder of the tibialis posticus and the inter-

- osseous membrane and the rest of the origins of the extensor longus digitorum and extensor proprius pollicis.
9. Divide the anterior and posterior superior tibio-fibular ligaments.
 10. If possible, find the cut ends of musculo-cutaneous anterior tibial nerves, and bring them accurately together with gut-sutures. The recurrent articular nerve is also divided in the substance of the peroneus longus, and in removing the upper extremity of the bone you cut through branches of the recurrent articular and inferior external articular arteries.

EXCISION OF THE ASTRAGALUS.

Steps of the Operation.

1. Make an incision across the front of the ankle joint from the tip of the outer malleolus to the tip of the internal malleolus. In this incision, which is slightly convex forwards, you divide *skin, superficial fascia*, containing small branches of the *external saphenous nerve*, the *external and internal divisions of the musculo-cutaneous nerve*, the *internal saphenous vein, lymphatics and nerve*, *anterior annular ligament*, the *tendons of the peroneus tertius, the extensor longus digitorum*, and beneath them the *extensor brevis digitorum* and part of the *external calcaneo-astragaloid ligament*. Internal to the extensor communis digitorum the *extensor longus pollicis tendon* is divided, and internal to the extensor longus pollicis the tendon of the *tibialis anticus* is cut through. The *dorsalis pedis artery* and its *venæ comites* are seen lying divided between the extensor proprius pollicis and extensor communis digitorum, and to its outer side the two divisions of the *anterior tibial nerve*. Branches of

the *anterior peroneal* and *external malleolar arteries* are divided externally, and branches of the *internal malleolar* internally.

2. Divide the ligaments of the ankle joint, afterwards those connecting the astragalus to the scaphoid, then raising the os calcis, divide the ligaments connecting it with the astragalus, free the posterior margin of the astragalus and remove the bone. In doing this you divide the *internal lateral ligament*, freeing at the same time the astragalus from it, the *anterior ligament* of the ankle joint, the *anterior fasciculus* and also the *middle fasciculus* of the *external lateral ligament*, if not divided before in the first incision. By tilting up the tibia, the *posterior fasciculus* of the *external lateral ligament* is divided as it passes obliquely backwards and inwards to the astragalus. You also divide completely the *external calcaneo-astragaloid ligament*, the *superior calcaneo-scaphoid ligament*, the *interosseous calcaneo-astragaloid ligament*, and finally the *posterior calcaneo-astragaloid ligament*. Pulling the bone well forward from its socket, the *flexor longus pollicis*, *posterior tibial nerve* and *artery* with its *venæ comites* and the tendons of the *long flexor of the toes* are separated from its posterior surface.
3. The cut extremities of the extensor tendons are now to be brought accurately into apposition by fine sutures, after which the edges of the wound are brought together and drainage tubes introduced.

EXCISION OF THE OS CALCIS.

Steps of the Operation.

1. An assistant holds the foot with its inner aspect lying on the table. Make a horizontal incision commencing at the

inner edge of the tendo-Achilles just above its insertion and running first outwards over the posterior aspect of the tendon, and then forwards along the outer surface of the os calcis and the cuboid just in front of the calcaneo-cuboid articulation. In making this incision cut down to bone. See Fig. 26.

2. Make a transverse incision down to bone, commencing in the horizontal one in the position of the calcaneo-cuboid articulation, cutting downwards over the outer border of the foot. Continue the incision inwards till you reach the internal limit of the under surface of the os calcis.

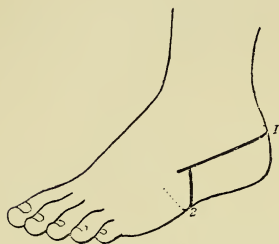


Fig. 26. Outer side of left foot and ankle.

1 indicates the horizontal incision, the dotted portion of the line being the commencement of the incision on the posterior and inner aspect of the heel.

2 indicates the transverse incision, the dotted line being that portion of the incision which extends across the sole of the foot.

In making the horizontal incision you divide *skin, superficial fascia*, containing inside and behind the tendo-Achilles branches of the *plantar cutaneous* of the *posterior tibial nerve*, with *internal calcanean branches* of the *posterior tibial artery*, and on the outer aspect of the foot, branches of the *external calcanean artery* and

anterior peroneal and the *external malleolar* and *tarsal arteries*, the *external saphenous vein*, *lymphatics* and *nerve*; *deep fascia*, *internal annular ligament*, *external annular ligament* and portion of the *anterior annular ligament*; beneath these structures the *tendo-Achilles*, the *bursa* between this tendon and the great tuberosity of the os calcis, the tendons of the *peroneus longus* and *brevis*, at this level contained each in a

separate *synovial* sheath ; beneath these tendons the *middle fasciculus* of the *external lateral ligament*, and the knife enters the muscular portion of the *extensor brevis digitorum*. Deeper branches of the arteries already enumerated are cut through in and beneath the deep fascia.

In the transverse incision you divide *skin, superficial fascia*, which is particularly thick in the sole, containing branches of the *external saphenous vein, nerve, lymphatics*, of the *plantar-cutaneous of the posterior tibial*, and of the *external plantar nerves and arteries*; *deep fascia*, blending in the outer border of the sole with the *outer divisions* of the *plantar fascia*, and this more internally is connected to the *middle division*; between the two the *external inter-muscular septum* is divided. You then divide the *abductor minimi digiti*, beneath it the *peroneus brevis* and the *peroneus longus* tendons, and internal to it and beneath the middle division of the plantar fascia, the *flexor brevis digitorum*, and lying beneath the *flexor brevis digitorum* the *external plantar artery and nerve*, and the tendinous outer head of the *accessorius*.

3. Turn the flap downwards from the outer surface of the os calcis, and then from its under surface, dividing on the under surface the origins of the *abductor minimi digiti* and *flexor brevis digitorum* from the outer and inner tubercles on the greater process of the os calcis and from the bone in front of them, the attachments of the *external annular ligament*, and of the *outer and middle division* of the *plantar fascia* to the tubercles.
4. Divide more completely the *extensor brevis digitorum*, also the ligaments connecting the os calcis to the neighbouring bones—namely, the *external calcaneo-astragaloid*, the *superior calcaneo-scaphoid*, the *internal calcaneo-cuboid*, and the *superior calcaneo-cuboid ligaments*.

5. Clear the fat away from the upper surface of the os calcis, and grasping this bone with a pair of lion forceps turn it outwards, dividing at the same time the interosseous and the posterior calcaneo-astragaloid ligaments. Turn the bone still further outwards, separating the tendon of the flexor longus pollicis from the groove beneath the sustentaculum tali, and then divide the internal lateral ligament at its attachment to the inner surface of the sustentaculum, avoiding the tendon of the flexor longus digitorum which lies internal to this process of bone. Divide the inferior calcaneo-scaphoid ligament with the subjacent insertion of the first slip of the tibialis posticus into the anterior margin of the sustentaculum, the short and long calcaneo-cuboid ligaments, the inner fleshy head of the accessorius at its origin from the inner concave surface of the os calcis, and the attachments of the abductor pollicis and of the inner division of the plantar fascia to the greater tubercle of the os calcis. Avoid injuring the posterior tibial artery, vein, and nerve, or any of the branches not already cut through in the transverse incision.

EXCISION OF THE FIRST METATARSAL BONE.

Various incisions are made for the removal of this bone, but the best is one along the inner aspect of the bone and following its curve.

Steps of the Operation.

1. Make a curved incision along the inner aspect of the bone, with the convexity of the curve directed upwards. The incision is to commence just behind the articulation with the cuneiform bone, and to end at the inner side of the base of the first phalanx.

In doing this you divide *skin, superficial fascia* containing branches of the *musculo-cutaneous* and *internal saphenous nerves*, *deep fascia*, the *inner division* of the *plantar fascia*, and a portion of the insertion of the *tibialis anticus*.

2. Reflect the convex flap downwards and the concave margin outwards, and clear the metatarso-phalangeal articulation, dividing the ligaments of this joint.
3. Grasp the head of this bone with bone forceps, and drawing it inwards, divide one by one all the structures attached to it and connecting it to the other bones. You avoid injuring the *dorsalis pedis* artery as it passes into the sole of the foot between the two heads of the first dorsal interosseous muscle.

In doing this you cut through the *internal* and *external lateral* and *plantar ligaments* of the metatarso-phalangeal articulation, the *deep transverse ligament*, the origin of the *first dorsal interosseous* from this bone, the *dorsal* and *plantar tarso-metatarsal ligaments*, the remainder of the insertion of the *tibialis anticus*, and the tendon of the *peroneus longus* at its insertion. Branches of the *internal plantar*, *first plantar digital*, and *dorsalis hallucis* arteries are divided.

SECTION IV.—EXCISION OF JOINTS OF LOWER EXTREMITY.

EXCISION OF THE HIP JOINT.

Steps of the Operation.

1. The patient being placed on the opposite side, the thigh is held slightly flexed. Make an incision five inches long in the adult, and relatively shorter in the child, from a point above the great trochanter, backwards and downwards, and then directly downwards behind it, so as to include it in its concavity. Some surgeons recommend that this incision be commenced at a point midway between the anterior superior spine and great trochanter, while others prefer to commence the incision just above the trochanter. Continue this incision down to the great trochanter, and to the back of the neck of the femur, dividing the great external rotator muscles.

In doing this you divide *skin*, *superficial fascia* containing much *fat*, and branches from the posterior division of the *external cutaneous*, the *iliac branch* of the *ilio-hypogastric*, the *lateral branch* of the *last dorsal*, the *external branches* of the *posterior divisions* of the *upper three lumbar nerves*, and of the *upper three sacral nerves*, with *ascending branches*

of the *small sciatic*. Beneath the superficial fascia, you divide *deep fascia*, and under this the *gluteus maximus* in the greater part of its breadth, with another layer of *deep fascia* beneath it. In the substance of the *gluteus maximus* branches of the *superficial branch* of the *gluteal artery* are divided.

Beneath the deep layer of fascia you cut through the *gluteus medius*; beneath it, in order from above downwards, the *gluteus minimus*, the *pyriformis*, the *obturator internus* with the *gemelli*, the *obturator externus*, the *quadratus femoris*, and the upper part of the *adductor magnus*.

The lower branch of the *deep division* of the *superior gluteal artery* with that of the *superior gluteal nerve* are divided between the *gluteus medius* and *minimus*, branches of the *obturator* and *internal circumflex arteries* are divided with the tendon of the *obturator externus*, and branches from the termination of the *internal circumflex* between the *quadratus femoris* and *adductor magnus*.

2. An assistant rotating the femur outwards, divide the structures attached to the outer and anterior surface of the great trochanter—namely, the *gluteus medius* at its insertion into the oblique line, opening the *bursa* between that tendon and the great trochanter, and the *gluteus minimus* where it is inserted into the anterior border of the great trochanter. Branches of the *ascending division* of the *external circumflex artery* will be divided in doing this.
3. The thigh being now rotated inwards, divide the capsule of the joint posteriorly near the acetabulum, cutting branches of the sciatic nerve and sacral plexus to the joint.

Lever the head of the bone out of the acetabular cavity, and divide the ligamentum teres with the small artery running in it. Then divide the ilio-trochantine and ilio-

femoral ligaments with the remainder of the capsule of the joint.

4. Clear the upper extremity of the femur at its junction with the lower border of the neck, and saw transversely through it at this level. In doing so you may divide the upper limit of the *vastus externus* while you open the *bursæ* over the outer aspect of this muscle and of the great trochanter.

In this operation, but especially in excision of the shoulder joint, Gowan's osteotome will be found most useful.

In some cases it is not necessary to remove the great trochanter, but the head may be alone removed by dividing the neck.

EXCISION OF THE KNEE JOINT.

Steps of the Operation.

1. Standing to the right side of the limb, of which the knee is held slightly flexed, make an incision with a slight convexity downwards from the back part of the inner condyle to the back part of the outer.

In doing this you divide *skin* and *superficial fascia* containing the *cutaneous patellæ*, and branches of the *internal, middle, and external cutaneous nerves*, with cutaneous branches of the *articular and anastomotica magna arteries*.

2. Reflect the skin and superficial fascia above the level of the upper border of the patella opening the *bursa patellæ*, and remove the patella.

In doing this you divide *fascia lata*, the *conjoined tendon* of the *quadriceps* muscle, the *anterior ligament* of the knee-joint with the *capsular ligament* attached to the lateral margins of the patella, and the *ligamenta alaria* and *mucosum*.

3. Now open the joint completely, anteriorly and laterally, dividing the remainder of the *capsular ligament* on the

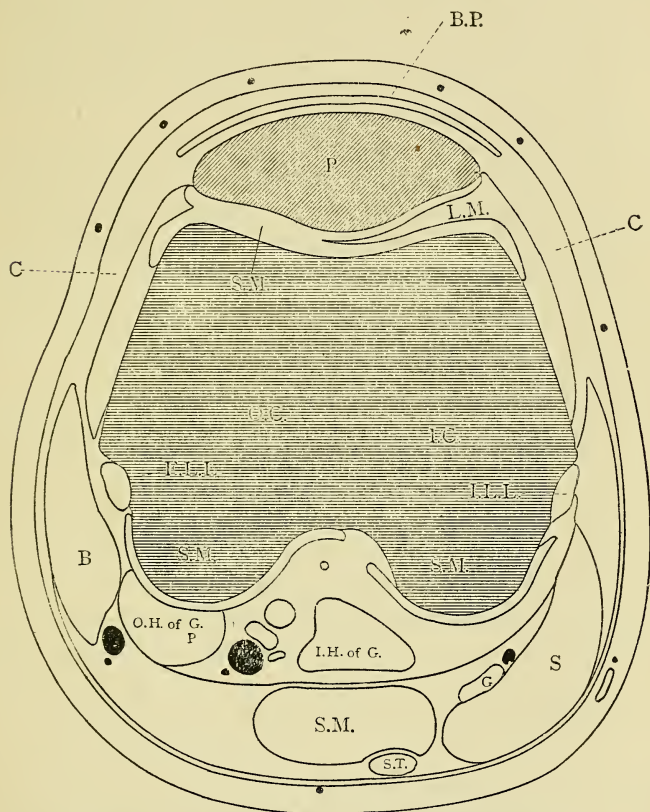


Fig. 27. Transverse section through condyles of femur.

front and sides of the articulation, the *internal lateral ligament*, the two divisions of the *external lateral ligament*,

and the tendon of the *popliteus*, which passes obliquely backwards beneath it, with the *inferior external articular artery*. Branches from all the *articular arteries* and of the *articular branch* of the *anastomotica magna* are divided. The *anterior* and *posterior crucial ligaments* surrounded in front and laterally by the same reflection of the *synovial membrane* are also cut through.

4. The condyles of the femur are now thrust well forwards, after flexing the knee, by displacing the upper extremity of the tibia backwards, and cutting the attachments of ligaments from the sides of the condyles. Taking care to saw horizontally through the femur, remove the lower inch of the bone in the adult, and relatively less in the case of young subjects, by this means avoiding any injury to the epiphysial line.
4. In the same way clear the upper extremity of the tibia for half an inch, removing the attachments of the internal lateral ligament and of the posterior ligament, also the insertion of the semi-membranosus into the back part and inner border of the head of the tibia. In clearing the posterior margin of the head of the tibia, remember that the popliteal artery is immediately behind its centre and only separated from it by a little fat. See Fig. 27.
5. Saw off the upper articular surface of the tibia, taking care to remove only that portion, and not to trespass on the growing line in the young subject.

EXCISION OF THE ANKLE JOINT.

Steps of the Operation.

1. Place the foot on its inner aspect on the table, an assistant holding it in that position. Make an incision three inches

long along the posterior border of the lower end of the fibula, and then continue it from the tip of the malleolus downwards and forwards to within half an inch of the posterior extremity of the fifth metatarsal bone. In doing this you divide *skin, superficial fascia with the external saphenous vein nerve and lymphatics*. See Fig. 28.

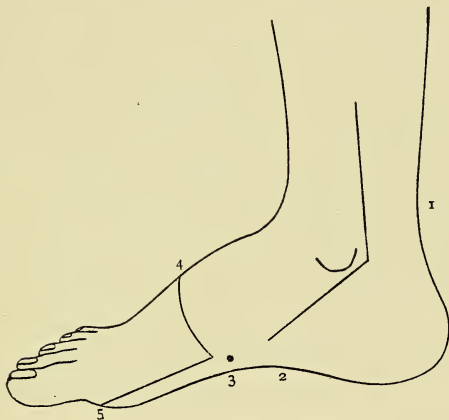


Fig. 28. Inner aspect of right foot and ankle.

1 indicates the vertical incision in excision of the ankle, and 2 the oblique incision. The anterior extremity of the latter incision terminates over the inner aspect of the internal cuneiform bone.

2. Reflect the skin and superficial fascia to a line joining the extremities of the incision.

Cut away the soft parts from the lower inch and a half of the fibula and divide the bone above with forceps. Then remove it. In doing this you divide *deep fascia*, attached to the margins of the *triangular subcutaneous surface* of the fibula and continuous below with the *external and anterior annular ligaments* which are also cut at their attachments

to the malleolus. In cutting these you open the *synovial sheaths* for the *peroneus longus* and *brevis* behind, and the *peroneus tertius* in front of the malleolus. Branches of the *anterior peroneal artery* are divided as they emerge from beneath the *peroneus tertius*. In dissecting out the bone you divide the lower part of the *interosseous membrane* with the *peroneal artery* on its posterior aspect, the *inferior interosseous ligament*, the *anterior* and *posterior inferior tibio-fibular ligaments*, and the three processes of the *external lateral ligament* of the ankle-joint. The *external malleolar artery* may be divided in this dissection.

3. The foot is now placed on its outer aspect on the table and retained in that position. Make an incision three inches long along the inner border of the tibia to the tip of the inner malleolus, and then from that forwards and downwards to the inner aspect of the internal cuneiform. You divide *skin*, and *superficial fascia* containing branches of the *internal saphenous vein*, *nerve* and *lymphatics*, the trunks of these vessels passing in front of the malleolus.
4. Reflect this flap to a line joining the beginning and end of your incision.
5. Divide deep fascia and the internal annular ligament continuous with it below where they are attached to the inner margin of the tibia and to the inner malleolus, exposing the tendons of the *tibialis posticus* and *flexor sublimis digitorum* covered by the *synovial sheath*: also the deep fascia and the anterior annular ligament where they are attached to the anterior margin of the tibia and malleolus, opening the *synovial sheath* of the *tibialis anticus*.

Divide the internal lateral ligament immediately below the tip of the inner malleolus, carefully avoiding the tendon of the *tibialis posticus* which lies upon it. Clear the tendons which lie on the posterior surface of the tibia.

from the bone, turning back also the posterior tibial artery with its venæ comites and the nerve which lies between the artery and the tendon of the flexor longus pollicis. The posterior communicating artery will probably be divided beneath the tendon of this last muscle.

6. Separate the tendons of the tibialis anticus, extensor proprius pollicis and extensor longus digitorum from the front of the lower end of the tibia, also the anterior tibial artery, its venæ comites, with the anterior tibial nerve lying to its outer side. These lie between the tendons of the extensor proprius pollicis and the extensor longus digitorum.

The internal and external malleolar artery are divided in separating these parts from the front of the tibia. Divide the anterior ligament of the ankle-joint.

7. Insert a narrow-bladed saw through the inner wound between the flexor tendons and the posterior surface of the tibia through the outer wound, and saw horizontally across the lower end of the tibia.
8. The foot being held firmly, remove the upper articular surface of the astragalus with the saw.

SECTION V.—EXCISION OF JOINTS OF UPPER EXTREMITY.

EXCISION OF THE SHOULDER.

Steps of the Operation.

1. Make an incision from the acromion down the centre of the outer aspect of the shoulder for about four inches, cutting down at once to bone. In this incision you divide—*skin, superficial fascia* containing *suprascapular* branches of the *cervical plexus* and branches of the *circumflex nerve* and of the *acromio-thoracic artery*, *deep fascia*, *deltoid*, *bursa* beneath *deltoid*, *posterior circumflex artery* winding forwards round the humerus, and the anterior branch of the *circumflex nerve*. The *supra-spinatus* and *capsule* of the joint are incised longitudinally.
2. An assistant rotating the humerus outwards, divide that portion of the *supra-spinatus* in front of the vertical incision together with that portion of the capsule with which it is closely connected. Cut through the fibrous covering of the bicipital groove derived from the upper margin of the tendon of the *pectoralis major*, and expose the long head of the *biceps* lying in the bicipital groove and passing within the capsule. It is seen to be accompanied by the

ascending branch of the anterior circumflex artery. Turn the tendon out of the groove, and divide the subscapularis, the bursa beneath it, and the portion of the capsule blended with it. Above it divide the coraco-humeral and glenohumeral ligaments.

3. The arm being rotated inwards by the assistant, divide the remains of the supra-spinatus, the infra-spinatus, and the teres minor, the bursa beneath the last muscle and that part of the capsule with which all these muscles are closely blended at their insertions. In cutting through these muscles branches of the posterior circumflex and acromiothoracic arteries are divided.
5. Turn the head outwards from the glenoid cavity and divide the lower portion of the capsule. Pass a chain saw around the surgical neck and remove the head and tuberosities. A small portion of the outer head of the triceps will be cut through just below the insertion of the teres minor.

Should the glenoid cavity be diseased, it may be removed by turning back the subscapularis, supraspinatus, and infraspinatus, detaching the attachment of the capsular ligament, and cutting through the neck of the bone with a chisel or bone-cutting forceps of a proper shape. In this case you cut through the long tendon of the biceps and branches to the joint from the supra-scapular artery and nerve, and from the artery to the venter of the scapula.

EXCISION OF THE ELBOW.

Steps of the Operation.

1. An assistant holds the arm in a position of extreme pronation. Make a vertical incision about four inches long over

the olecranon, the centre of the incision corresponding to the tip of this process, cutting at once down to bone. In doing this you divide *skin, superficial fascia* with a *bursa* between it and the triangular subcutaneous surface of the olecranon. In the superficial fascia are divided branches of the *lesser internal cutaneous*, of the *intercosto-humeral*, and of the *lower external cutaneous branch of the musculo-spiral nerves*. The *deep fascia* is next cut through, and beneath it the *triceps, subanconeus*, and *posterior ligament* of the elbow joint, with the *nerve to the anconeus*, the *posterior articular artery*, and branches of the *anastomotica magna artery*.

2. Turn the soft structures inwards and then forwards from off the back and side of the inner aspect of the joint, avoiding carefully the ulnar nerve. You divide in so doing the attachment of the *triceps* to the inner half of the upper aspect of the olecranon, the origins of the *flexor carpi ulnaris* and *flexor profundus digitorum* from its inner aspect, the origins of the *flexor carpi ulnaris*, *palmaris longus*, *flexor sublimis digitorum*, and *flexor carpi radialis* from the internal condyle, the *internal lateral* and the inner portion of the *posterior ligaments*. Branches to the joint from the *posterior ulnar recurrent*, *superior profunda*, and *anastomotica magna arteries* are cut through, with *articular branches of the ulnar nerve*.
3. Clear the external condyle in a similar way. In doing this you divide the insertion of the *triceps* into the outer half of the upper surface of the olecranon, the *anconeus* at its insertion and again at its origin from the back of the external condyle, the *supinator brevis* at its origin from the oblique line of the ulna, the surface of bone in front of it, the external condyle, external lateral and orbicular ligaments, then the *extensor carpi radialis longior* and *brevior*,

- the *extensor carpi ulnaris*, and the *extensor communis digitorum*. Articular branches from the *posterior interosseous recurrent*, *anastomotica magna* and *superior profunda* arteries are cut through. The *external lateral ligament* and the outer portion of the *posterior ligament* are divided.
4. Flex the joint completely, clearing away the anterior attachments of the lower end of the humerus, which now projects from the wound. You will find it facilitates matters to snip off the olecranon before clearing the anterior surface of the humerus. Saw transversely through the humerus just above the condyles. In doing this you divide the *anterior ligament of the joint*, the *pronator radii teres* where it arises from the front of the internal condyle, and the lower limit of origin of the *brachialis anticus*.
 5. Clear in a similar manner the front of the upper ends of the ulna and radius. In doing this you divide the lower attachment of the *anterior ligament* of the elbow joint, the insertion of the *brachialis anticus*, the origins of the *flexor profundus digitorum*, *flexor sublimis digitorum*, and the *flexor longus pollicis* from the coronoid process, and of the *supinator brevis* from the upper part of the radius. In dividing the bones, you also divide the *oblique ligament*. Articular branches of the *radial recurrent*, *anterior ulnar recurrent*, *superior profunda*, *inferior profunda*, and *anastomotica magna* arteries are divided in clearing the bones in front.

EXCISION OF THE WRIST JOINT.

LISTER'S METHOD.

Steps of the Operation.

1. Carefully define the position of the radial artery as it lies

on the bases of the first and second metacarpal bones, and the line taken by the tendon of the extensor secundi internodii pollicis, as it passes obliquely downwards and outwards to cross the radial artery, just as it is getting on the bases of the metacarpal bones.

Make an incision parallel to and on the inner side of the obliquely placed tendon of the extensor secundi, commencing above at the lower margin of the radius, and ending on the radial side of the base of the second metacarpal internal to the radial artery. Continue this incision vertically downwards along the upper half of the radial border of that bone. In doing this you divide *skin, superficial fascia* with branches of the *external cutaneous* and *radial nerves*, the *posterior annular ligament*, branches of the *anterior interosseous, posterior carpal* and *metacarpal* branch of the *radial*, and possibly the *radialis indicis*.

2. Passing a knife beneath the tendons of the extensor carpi radialis brevior, separate it from its insertion into the radial side of the base of the third metacarpal bone, from the back of the carpus and from the lower part of the radial groove.

Separate the tendon of the extensor carpi radialis longior in a similar way from its insertion into the radial side of the base of the second metacarpal bone, from the back of the carpus and from the lower part of the radial groove.

Separate the tendon of the extensor secundi from the back of the carpus and from the lower part of the oblique groove in the back of the radius.

Separate the radial artery with its *venæ comites* from the scaphoid, trapezium, and external lateral ligament of the wrist where it lies upon them.

Snip through the trapezium where it articulates with the scaphoid and trapezoid, dividing a portion of the external

lateral ligament of the wrist and carpus with the palmar and dorsal ligaments connecting it to adjacent bones. Divide the external lateral ligament below the styloid process.

3. Turning to the ulnar side of the incision, the extensor carpi radialis tendons having been already cleared, separate the extensor communis digitorum and the extensor indicis from the posterior aspect of the bases of the metacarpal bones, from the carpus and from the lower end of the radius, cutting the terminal branches of the posterior interosseous nerve and further branches of the posterior carpal arch.

Separate in the same way the extensor brevis minimi digiti, which lies alone in the groove between the radius and ulna. Branches of the posterior interosseous artery will be divided in clearing this tendon.

4. Make a vertical incision along the inner aspect of the ulna from a point two inches above its lower extremity, and carry that incision downwards as far as the centre of the fifth metacarpal bone on its palmar aspect. In doing this you divide skin, superficial fascia containing branches of the internal cutaneous nerve, then deep fascia, and below the inner division of palmar fascia in the lower part of the incision. The posterior carpal artery is cut through on the inner aspect of the wrist.
5. Raise the posterior lip of this incision, and separate the extensor carpi ulnaris from the groove between the styloid process and the head of the ulna, from the back of the carpus, and from its insertion into the base of the fifth metacarpal bone. Complete the separation of the extensor minimi digiti and the extensor communis digitorum.

Divide the internal lateral ligament of the wrist just below the styloid process, and then the posterior ligament of this joint.

6. Clear the anterior surface of the lower extremity of the ulna, opening the little articulation between the cuneiform and pisiform bones by dividing its thin capsular ligament, and snip through the base of the unciform process of the unciform bone. Clear the anterior surface of the base of the fifth metacarpal bone by separating the tendon of the flexor carpi ulnaris from its insertion into it. Separate the flexor profundus digitorum and the flexor longus pollicis tendons from the front of the carpus. Divide the anterior ligament of the radio-carpal articulation with terminal branches of the anterior interosseous and anterior carpal arteries. Clear the anterior surfaces of the bases of the metacarpal bones of the second, third, and fourth digits, avoiding carefully the deep arch which lies on these bones. In clearing them you separate the origin of the flexor brevis pollicis from the trapezoid, os magnum, and the bases of the second and third metacarpal bones.
7. The greater part of the carpal bones may now be removed by cutting through the lower row with forceps, so dividing the dorsal and palmar ligaments connecting them. Make lower end of the ulna project out of the inner incision and saw it through, dividing the interarticular fibro-cartilage, and the inferior anterior and posterior radio-ulnar ligaments.

Turn the lower end of the radius out of the dorsal incision, and saw transversely through it in a similar manner above the radio-ulnar articulation.

Project the ends of the metacarpal bones through either incision, and with bone forceps snip off their bases so as to remove the whole of the cartilage-covered portion, dividing dorsal and palmar carpo-metacarpal, and the dorsal and palmar intermetacarpal ligaments.

Remove the trapezium, separating from it the tendon of the flexor carpi radialis which grooves it, and divide the capsular ligament that connects it to the base of the first metacarpal.

Separate the extensor ossis metacarpi pollicis from its insertion into the base of the metacarpal bone, and remove its articular extremity with cutting forceps.

SECTION VI.—EXCISION OF ORGANS.

EXCISION OF THE EYEBALL.

Steps of the Operation.

1. Introduce a spring speculum between the eyelids.

Grasp the conjunctiva and subconjunctival tissue with a pair of forceps as near the corneal margin as you can, and snip through the conjunctiva and subjacent areolar tissue in a circle round the cornea. You do this with a pair of blunt-pointed curved scissors.

2. You expose the capsule of Tenon covering the sclerotic in front. Divide this and pass in a strabismus hook, sweeping it round the globe of the eye, pick up in turn each of the recti tendons at its insertion into the sclerotic, and divide them with the scissors.
3. Press back the blades of the spring speculum so that the globe of the eye presses forwards between, and finally projects beyond them.
4. Using the scissors with their blades turned with their concavity to the globe, and following the posterior surface of the globe with their extremities, divide the optic nerve at its entry into the sclerotic. This point is inside the axis of the eye. Lastly, divide the oblique muscles at their insertions. Besides these structures you divide the anterior, long, and posterior ciliary arteries, the long and

short ciliary nerves, and the arteria centralis retinae with its accompanying vein in the substance of the optic nerve.

KOCHER'S OPERATION FOR EXCISION OF THE TONGUE.

In Kocher's operation the tongue and lymphatic glands are removed through an inframaxillary incision, tracheotomy being first performed.

Steps of the Operation.

1. Perform tracheotomy according to rules given for that operation. See Fig. 29. Introduce a Trendelenburg's canula. Should severe dyspnoea ensue on inflating it, substitute an ordinary canula. Wash the mouth and pharynx out with a sponge and carbolic lotion, and then fill the pharynx with a sponge saturated with carbolic acid lotion (1 in 40).
2. Ligature the lingual on the opposite side of the neck to that affected by the growth, following instructions given for ligature of that artery.
3. Extend the neck, drawing the head to one side. Make an incision commencing a little below the lobule of the ear, and running along the anterior margin of the sterno-mastoid to the hyoid bone. Continue this incision along the greater

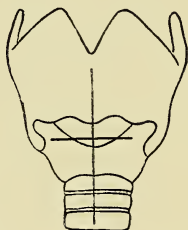


Fig. 29. The vertical line indicates the skin incision in superior tracheotomy, and the horizontal line shows the position of the transverse incision through the deep fascia.

cornu to the body of the bone, and then run along the anterior belly of the digastric to the jaw. See Fig. 30.

4. Now cut through superficial fascia and platysma dividing branches of the inframaxillary branches of the facial

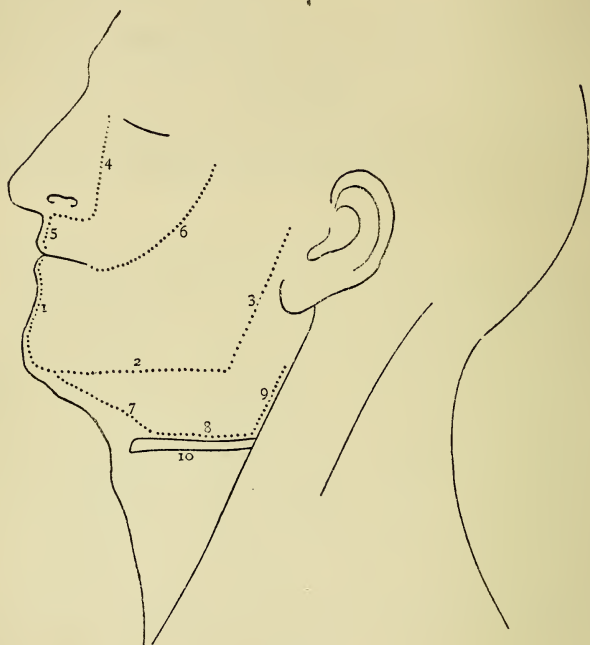


Fig. 30.

10 indicates the position of the hyoid bone, and 7, 8, and 9 the incisions for removal of the tongue by Kocher's method. The continuous line parallel to 9 is the anterior margin of the sterno-mastoid.

nerve, anterior branches of the great auricular, and ascending branches of the superficial cervical nerves. Avoid the external jugular vein.

5. Turn up this flap as far as the body of the jaw, exposing

deep cervical fascia. Cut through this deep fascia along the line of the primary incision, removing it and exposing the submaxillary gland and the facial or common facial vein, as the case may be, passing over the gland. Some diseased lymphatic glands may now be seen. Ligature and cut through the lingual vein which is seen lying below the facial, and this you now treat in a similar way. Ligature the facial artery as it enters the gland, and after its exit from it. Cut away any enlarged lymphatic glands and the portion of submaxillary gland exposed, dividing and ligaturing the submental artery. The muscles forming the floor of the submaxillary region are now exposed, namely, the anterior belly of the digastric lying on the mylo-hyoid, the posterior belly of the digastric with the stylo-hyoid passing downwards and forwards, and in the interval between these two muscles and the mylo-hyoid is seen a little of the stylo-glossus with the hyo-glossus below it. A little of the middle constrictor is seen covered by fascia. The hypoglossal is seen lying just above the great cornu of the hyoid bone on the hyo-glossus, then passing beneath the tendons of the digastric and stylo-hyoid. The lingual artery is seen lying beneath the hypoglossal upon the middle constrictor. It is seen to pass under the hyo-glossus. Ligature and divide it. The cut portion of the submaxillary gland is seen beneath the mylo-hyoid. The mylo-hyoid nerve and artery are seen lying on that muscle.

6. Separate the mylo-hyoid muscle from its attachment to the jaw as far forward as the anterior belly of the digastric, and expose the deep part of the submaxillary gland with its duct. This is now seen to pass beneath and internal to the sublingual gland, which is now exposed. The lingual gustatory nerve is seen looping round the duct of

the submaxillary gland, and giving off its branches to the submaxillary ganglion, which lies just above the deep process of the submaxillary gland.

7. Remove these structures and cut through the mucous membrane along the jaw. The tongue can now be drawn out through this opening, and removed either by the knife or by the cautery. Kocher prefers the cautery, as there is less oozing after it. As the structures divided in this stage of the operation resemble almost exactly those cut through in Whitehead's operation, I will refer the reader to that description.

The whole operation may be performed under the carbolic spray, or what seems preferable, the parts may be thoroughly washed with carbolic lotion (1 in 40) on the completion of the removal of the tongue. If the operation is an extensive one do not sew up the external wound, but see that the discharge escapes freely through it into a surrounding loose antiseptic dressing. Plug the whole cavity of the mouth and pharynx with a dressing of gauze soaked in a five per cent. solution of carbolic acid, washing the tampon over with water before applying it to the mucous membrane. Change the dressings twice a day under spray, feeding the patient through a tube at the same time. Nutrient enemata should also be given in the intervals between the dressings.

The three great advantages Kocher claims for this operation are that it does away with any danger from hæmorrhage, general sepsis, and pneumonia.

WHITEHEAD'S OPERATION FOR EXCISION OF THE TONGUE.

In Whitehead's operation, the tongue is removed through the mouth by the scissors. I will give the operation almost in his own words, merely introducing the anatomical details.

Steps of the Operation.

1. The mouth is opened to the full extent with Mason's or any suitable gag, the duty of attending to this being entrusted to one of the two assistants required. Gowan's gag is probably the best for the purpose.
2. The tongue is drawn out of the mouth by a double ligature passed through its substance an inch from the tip. The ligature is given in charge of the second assistant, with instructions to maintain throughout the operation a steady traction outwards and upwards.
3. The operator commences by dividing all the attachments of the tongue to the jaw and to the pillars of the fauces, after the manner suggested by Sir James Paget, with an ordinary pair of straight scissors. In doing this, the mucous membrane, forming the frænum, is cut in front with the genio-hyoglossus muscles. The submaxillary duct and the sublingual gland will probably be partially or completely divided at this stage of the operation with branches of the lingual artery to the sublingual gland, and to the mucous membrane. The palato-glossus muscle and the mucous membrane covering it are also divided with small twigs of the palatine arteries and nerves.
4. The muscles attached to the base of the tongue are then cut across by a series of successive short snips with the scissors, until the entire tongue is separated in a plane of the inferior border of the lower jaw, and as far back as the safety of the epiglottis will permit.

The muscles cut through in this stage are a further portion of the genio-hyoglossus muscles, the hyo-glossus with the superior constrictor internal to it, and the stylo-glossus external to it, and the inferior lingualis muscles. Then the vertical and transverse muscular fibres, the fibrous

septum, the superior lingualis muscle, and the central and lateral glosso-epiglottidean folds of mucous membrane are cut through. The lingual arteries and veins are divided between the hyoglossus and genio-hyoglossus muscles. Above it the glosso-pharyngeal nerve is cut through, it having already split into two large branches. The lingual gustatory nerves are divided as they pass from beneath the attachments of the superior constrictor muscles to the jaw, and its branches to the submaxillary ganglion are also removed. The hypoglossal nerve is divided in its branches of distribution to the several muscles.

5. The lingual or any other arteries requiring torsion are twisted as divided. It is generally found that a moment's pressure with a small piece of sponge, held in sponge forceps, suffices temporarily, if not permanently, to arrest any bleeding; it is, however, regarded as desirable to twist, either immediately, or after the tongue is removed, every bleeding vessel.
6. A single loop of silk is passed by a long needle through the remains of the glosso-epiglottidean fold of mucous membrane as a means of drawing forwards the floor of the mouth, should secondary hæmorrhage take place. The ligature may with safety be removed the day after the operation; and as it is invariably a source of annoyance to the patient, it is always desirable to adopt this rule.

The after treatment consists in feeding the patient for the first three days absolutely and solely by nutrient enemata, satisfying thirst by occasionally washing out the mouth with a weak iced solution of permanganate of potash, forbidding any attempt at speaking, and requiring that all the wishes of the patient be expressed in writing. Hæmorrhage is easily controllable, and frequently trifling.

EXCISION OF THE LARYNX.

Steps of the Operation.

1. The patient is placed on his back. Make a median incision through skin, superficial fascia and platysma, from the lower border of the hyoid bone to the level of the second ring of the trachea. You may divide in this incision the anterior jugular vein, and branches of the facial and superficial cervical nerves.
2. Cut through deep cervical fascia along the whole length of the incision, avoiding the isthmus of the thyroid gland in the lower angle of the incision, and exposing from above downwards thyro-hyoid membrane, thyroid cartilage, crico-thyroid membrane with the crico-thyroid artery, and below the cricoid cartilage the upper two rings of the trachea. Some veins may be divided beneath the deep fascia just above the isthmus.
3. Separate the sterno-hyoid and omo-hyoid muscles from the larynx, or divide them if necessary. Cut through the sterno-thyroid, inferior constrictor, and thyro-hyoid muscles at their attachments to the oblique line and surface of cartilage behind it.

Separate the upper part of the lobes of the thyroid body from the larynx.

Ligature the superior thyroid arteries and veins before they give off the internal laryngeal branches.

Separate the inferior constrictor from its attachment to the inferior cornu of the thyroid cartilage and the fascia covering the crico-thyroid muscle dividing the external laryngeal nerves.

4. Now transfix the upper part of the trachea with a short hook,

- and, raising it, divide it, separating it from the larynx, and taking care not to injure the œsophagus. The recurrent laryngeal nerves are divided in doing so. Introduce into it a large syphon vulcanite tube which fits it.
5. Divide the central and lateral thyro-hyoid ligaments, and the internal laryngeal nerve and artery. Raise the larynx and divide the attachments of the stylo- and palato-pharyngeus muscles to the posterior borders of the thyroid cartilage, and the attachment of the longitudinal fibres of the œsophagus to the ridge on the back of the cricoid. Separate the larynx from the mucous membrane and sub-mucous tissue of the pharynx dividing it along the margin of the upper aperture of the larynx.
 6. Divide lastly the hyo-epiglottic ligament and the glosso-epiglottic folds of mucous membrane, and remove the larynx.

This method is based on the same lines as that described by Dr. Foulis.

EXCISION OF THE BREAST.

Steps of the Operation.

1. The patient is placed on her back, and her arm is abducted.
Make an elliptical incision, with its concavity directed upwards, from a point inside the inner margin of the breast, outwards below the nipple to a point well outside the outer margin. The outer extremity of this incision will end in the axilla, and it may be prolonged still further into the space, if the presence of enlarged glands are suspected. Many prefer to make the extended incision in all cases, and to remove any gland that can be felt, whether healthy or otherwise.

2. An assistant raises the breast, while you dissect the skin and subcutaneous tissue from it till you reach the lower margin of the breast.
3. Proceed to separate the breast from the layer of deep fascia which covers the pectoralis major in front.
4. Now make another elliptical incision, commencing and ending in the extremities of the former incision, having its concavity directed downwards, and being placed at a variable distance above the nipple.

An assistant draws the breast down, while you raise the flap upwards, and dissect the skin and subcutaneous tissue from the upper and anterior surface of the breast, till you reach its free margin.

5. Should you desire to remove the glands, cut through the deep fascia forming the base of the axilla and introduce your finger into the space. You will easily detect the glands, and, if not very large and surrounding the vessels, they can now be dissected out.

In removing the breast you divide in the superficial fascia branches of the anterior termination of the second, third, and fourth intercostal nerves, with the anterior divisions of the lateral cutaneous branches of the third and fourth intercostal nerves. In removing the breast, perforating branches of the internal mammary artery, of the second, third, and fourth intercostal, and of the long thoracic arteries are cut through.

Branches of the alar thoracic artery may also be divided.

The axillary glands are about twelve in number, they are mostly placed along the axillary vessels, but a few lie further forwards on the serratus magnus, near the external mammary artery, and beneath the pectoral muscles. These last receive lymphatics from the breast. Some others are

placed at the posterior boundary of the axilla, and receive lymphatics from the back.

LUMBAR NEPHRECTOMY.

Many different incisions are used for the removal of the kidney through the loin. That employed by Mr. Clement Lucas appears to be the most satisfactory, as it affords the largest space for manipulation. Some writers have objected to it, as they say that its upper end is in dangerous proximity to the pleura, which, in some cases, descends below the last rib. They forget, however, that the lower limit of the pleura is in these cases internal to the vertical incision. I have gone into this subject in detail in a paper in the "Journal of Anatomy and Physiology," 1886—"Some Variations in the Human Skeleton"—and I showed there that the lower limit of the pleura varied in extent directly as the length of the lowest ribs. When the length of the twelfth rib was under two inches, the pleura only reached its upper border or its anterior surface internally; and when the rib was more than three inches long, the lower limit of the pleura crossed its centre obliquely from without inwards, only extending below the inner third of its length.

Steps of the Operation.

1. The patient is placed on the opposite side to that on which the operation is to be performed, and the loin is stretched by a firm horse-hair bolster introduced beneath the patient so that the thorax drops on one side and the pelvis on the other. An assistant steadies the pelvis with one hand, whilst with the other he supports the abdomen and presses the kidney upwards into the loin. Next define the position

and length of the last rib, and the border of the erector spinæ. The surgeon stands behind the patient and begins by making an oblique incision parallel with the last rib, and about a finger's breadth below it. This incision should be about four inches in length, the extremity of the last rib corresponding to about its centre.

2. In this oblique incision you divide in succession skin, superficial fascia containing cutaneous branches of the posterior division of the twelfth dorsal nerve and artery, deep fascia, latissimus dorsi, with a small portion of the external oblique; beneath the latissimus a further portion of the external oblique, with the serratus posticus inferior; beneath these the internal oblique, arising at this level from the undivided aponeurosis if the quadratus is not more than usually broad; beneath this the transversalis muscle and its undivided aponeurosis. (I would again remind the reader that in the large majority of bodies the outer border of the quadratus lumborum is directed from above obliquely downwards and outwards, and that the upper part of the outer border is covered by the erector spinæ, while the lower portion projects outwards beyond it.)

The transversalis aponeurosis is here seen to give off directly the lumbar aponeurosis.

Beneath it you divide transversalis fascia and expose the layer of perinephritic fat, in which you can feel the kidney.

3. Make an incision along the outer border of the quadratus lumborum, commencing at the upper edge of the twelfth rib and extending to the iliac crest. Owing to the great variations in the length of the last rib and of the quadratus, the direction of this incision varies within considerable limits.
4. In the more vertical incision you divide skin, superficial

fascia containing cutaneous branches of the posterior divisions of the twelfth dorsal and upper three lumbar nerves and arteries, deep fascia, latissimus dorsi, serratus posticus inferior, external abdominal oblique, the internal abdominal oblique arising above from the lumbar aponeurosis, and in the lower part of the incision arising from the lamella of transversalis aponeurosis that passes behind the quadratus lumborum; beneath this you cut through the undivided transversalis aponeurosis, the last dorsal nerve and artery, the ilio-hypogastric if it is placed pretty high up, and branches of the lumbar arteries.

The transversalis fascia is then exposed and cut through, and the layer of perinephritic fat is seen at the bottom of the wound. In those rare cases in which the quadratus is very broad above, this muscle with its sheath may be safely divided in the upper oblique incision to the outer margin of the erector spinæ.

5. If the last two ribs are long, they will now be found to be a good deal in the way. An assistant draws them upwards by means of a strong blunt retractor. Separate the kidney from its surroundings by means of the finger. Should there be no adhesions this is easily done; but when the operation is performed for suppurating or strumous kidneys subsequent to nephrotomy it is necessary to open the fibrous capsule of the kidney and strip it out, leaving this covering behind.
6. If the kidney be free from adhesions, the lower end should be first raised, the ureter found, enclosed in a double catgut ligature, and divided. This gives greater freedom to the organ and enables the surgeon to separate it more readily above. It is then gently raised through the wound, a double ligature is passed with a blunt aneurism needle between the vessels, which are tied in two loops. If the

kidney be adherent, it is removed from within its capsule, which is stripped back on to its pedicle. The pelvis of the kidney is then transfixed by a double ligature and included with the vessels in the double loop.

ABDOMINAL NEPHRECTOMY.

There are two incisions used for the ventral operation, one in the median line, the other (Langenbeck's) on the outer side of the rectus muscle. The latter, from being more directly over the organ and from the opening allowing of extension by an incision directed towards the loin, is growing in favour.

A.—ABDOMINAL NEPHRECTOMY BY MEDIAN INCISION.

Steps of the Operation.

1. The patient is placed on the back. Make a vertical incision in the median line about six inches in length, four inches being above and two below the umbilicus. The length of this incision varies with the size of the tumour to be removed. You divide skin, superficial and deep fascia, the conjoined aponeurosis of the external and internal oblique and transversalis muscles with the transversalis fascia. You may divide small branches of the superior and the deep epigastric arteries which cross in the middle line.
2. Having stopped every bleeding point, divide the subperitoneal fat, and raise the exposed peritoneum with a pair of forceps, make a small opening into it. Introduce a director, and divide the peritoneum on it for the whole extent of the skin incision. The suspensory ligament of the liver should be avoided.
3. Introduce your fingers, then your hand, through the opening, the assistant carefully guarding the margins of the

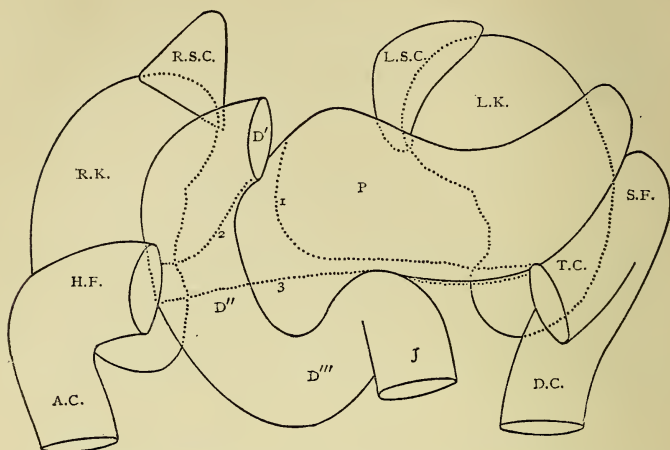


Fig. 31 shows the relations of the kidneys, supra-renal capsules, duodenum, colon, and pancreas to one another.

The several viscera are indicated by their initial letters.

The dotted outline indicates that portion of each viscus which is covered by the adjoining viscera.

The dotted line 1 represents the limits of the lesser bag, and where it extends horizontally to the left, it represents the ascending layer of the transverse meso-colon.

2 indicates that portion of the ascending layer of the transverse meso-colon which is formed by the peritoneum of the greater bag.

3 shows the line of reflection of the descending layer of the transverse meso-colon.

D' is the first portion of the duodenum.

D'' „ second „ „

D''' „ third „ „

J „ commencement of the jejunum.

A.C. „ ascending colon.

H.F. „ hepatic flexure.

T.C. „ transverse colon.

S.F. „ splenic flexure.

D.C. „ descending colon.

P „ pancreas.

wound in the abdominal wall, to prevent the escape of intestine through it. Carefully define the shape of the kidney and its connections; should there be any adhesions to surrounding structures, they should be ligatured and divided.

4. Draw the small intestines and colon from off the surface of the kidney, towards the opposite side, using a large flat sponge to retain them in that position. See Fig. 31.

Divide the outer layer of the meso-colon, where it covers the kidney, sufficiently to allow of the removal of the tumour through the wound made in it. The outer layer of the meso-colon is divided instead of the inner, because the colic vessels run in the latter layer.

5. Clear the front of the kidney, separating from it peritoneum and duodenum on the right side, and on the left side peritoneum, pancreas, and splenic artery and vein, with the inferior mesenteric vein. The supra-renal capsule must also be left behind.
6. Clear the renal vessels, ligaturing the artery and the vein separately if possible. You should remember in looking for the renal vessels that it is by no means uncommon for large branches to the kidney to come off from the aorta much lower down than the normal renal, or from the common iliac artery. In these cases the lower branches very frequently do not enter the kidney at the hilum, but perforate the cortex at some distance from it. The kidney may also receive branches from neighbouring vessels. The veins are also occasionally very abnormal. In the abnormality paper in the Guy's Hospital Reports, 1886, there is a drawing of a kidney in which these conditions are all well shown. Though such an extreme variation from the normal is certainly unusual, lesser deviations are not uncommon.

Clear the ureter, and ligature it firmly, remembering that it, like the artery and veins of the kidney, is occasionally abnormal.

7. Enucleate the kidney, and divide the arteries, veins, and ureter beyond the ligatures. Mr. Knowsley Thornton fixes the cut end of the ureter in the abdominal incision, so as to prevent the escape of any of its contents into the abdomen. Sir Spencer Wells advises that the edges of the wound in the peritoneum at the back of the abdomen should now be brought together with gut sutures.
8. The edges of the abdominal incision are brought together, great care being taken to see that the peritoneal surfaces are in exact opposition all along the line. Some surgeons, as Sir Spencer Wells, prefer to suture the peritoneal edges together before bringing the skin and muscle together. If this is not done the sutures should pass through skin, muscle wall, and peritoneum.

B.—ABDOMINAL NEPHRECTOMY BY LANGENBECK'S INCISION.

A vertical incision is made over the *linea semilunaris* extending from near the margin of the ribs downwards for about four or six inches. Any vessels divided are secured before the peritoneum is opened. The subsequent steps in this operation are similar to those employed in the operation already described, the organ being reached through the outer layer of meso-colon. The advantages of this incision are, that being more directly over the organ, it enables the surgeon to reach and secure the vessels with greater ease, and in the case of a large tumour the additional incision may be carried towards the loin, through which, if necessary, drainage may be established. In both abdominal operations two layers of peritoneum are divided before the organ is reached.

OVARIOTOMY.

Steps of the Operation.

1. The bladder is emptied before the operation. The number of sponges and forceps are counted. A piece of gutta-percha sheeting, with an oval opening cut in it about sixteen inches long by twelve broad, is fixed by an adhesive compound to the skin of the abdomen, so that it covers the pubes below, and the abdomen some way above the umbilicus, leaving the intervening part exposed.
2. Having thoroughly cleansed the surface of the abdomen, make a median incision from the umbilicus to the pubes, dividing skin and superficial fascia, then the aponeurosis formed by the union of the tendons of the external and internal oblique and transversalis. Should the incision be a little to one side, the pyramidalis and rectus may be incised in their sheath. Then divide transversalis fascia. Some small branches of the superficial and external pudic, and of the superior and deep epigastric arteries may be cut through, and must be carefully ligatured before the next stage of the operation.
3. Pick up the peritoneum and subperitoneal tissue with forceps, and, making a small opening in the peritoneum, introduce a director or a finger, and extend the peritoneal incision to the extent of the skin wound, avoiding the bladder.
4. The tumour is now exposed. The hand is introduced and swept round its surface to find its extent, and the presence of adhesions, if any. Plunge into the centre of the tumour a large trocar, with hooks which grasp the margin of the ovarian opening. As you empty the tumour you can gra-

dually withdraw it from the abdomen, breaking through any adhesions that may be present, or, if strong, ligaturing and dividing them.

5. Having defined the pedicle of the tumour, perforate its centre with a double silk ligature, and tie in two portions, or, if the pedicle is broad, in several. Divide beyond the ligature and allow the pedicle to fall back into the abdomen.
6. Carefully remove with sponges any fluid that may be present in the abdomen, and bring the edges of the wound in the abdominal wall together with silver sutures, taking care to include peritoneum, and to see that the opposing surfaces of peritoneum are in exact apposition; or the peritoneal edges may be brought together separately.
7. The sides of the abdomen must now be supported with bands of strapping which cross the wound at right angles, the dressing applied, and a broad bandage then firmly covers the whole abdomen and supports it.

In Battley's operation the ovary is removed in a similar manner, though in that case the abdominal incision is not usually so extensive.

CASTRATION.

Steps of the Operation.

1. The scrotum is to be shaved and washed very thoroughly with carbolic lotion. This is better done some time before the operation.

Grasp the testis with the left hand, and make an incision from the external abdominal ring to the bottom of the scrotum. Should the disease for which the testis is removed involve skin, two elliptical incisions should be made instead. In making this incision you divide skin

and superficial fascia, above consisting of two layers, the superficial containing fat, the deeper being thin and membranous. In the scrotum these layers are blended to form the dartos, which is closely connected to the skin. The superficial external pudic artery and vein are divided in the superficial fascia covering the cord in front, and branches of the superficial perineal artery in the dartos. Branches of the ilio-inguinal and of the three long scrotal nerves are also cut through.

2. Now separate the testicle and cord with their coverings from the dartos, to which they are but loosely connected. An assistant holds the testis while you open the sheath of intercolumnar fascia and cremastic muscle that surrounds the cord just below the external ring.
3. Pass a double carbolized silk ligature through the cord, and tie it in two parts.
4. Cut through the cord with its coverings of intercolumnar fascia and cremastic muscle immediately below the ligature, and remove the testis.

In doing this you divide in the intercolumnar fascia, branches of the superficial and deep external pudic arteries and veins of the ilio-inguinal nerve; in the cremastic muscle the cremasteric branch of the deep epigastric and the genital branch of the genito-crural; the structures forming the cord, enclosed in a process of intercolumnar fascia, and supported by areolar tissue continuous above with subperitoneal fat; viz., the vas, with the artery to the vas, the spermatic artery, veins, nerves, lymphatics, and the obliterated process of peritoneum.

Should it be necessary to divide the cord higher up, the anterior wall of the inguinal canal should be carefully divided on a director.

It is sometimes recommended to shell off the coverings

of the cord and testis. This is usually a needless and a difficult process.

In doubtful cases it is wise to open the tunica vaginalis, and examine the testis before proceeding to remove it.

AMPUTATION OF THE PENIS.

The best form of this amputation is that described by Mr. Jacobson in Holmes' System, vol. iii.

Steps of the Operation.

1. Cut a convex flap of skin from the dorsum and sides of the penis, dividing skin and the loose subcutaneous tissue. Reflect this flap. The dorsal vein with the arteries on either side of it are picked up and ligatured.
2. Insert a narrow-bladed knife through an angle of the flap, passing it between the corpus spongiosum and the united corpora cavernosa, and then cause it to emerge through the outer angle of the dorsal flap. Now cut obliquely downwards and forwards, so as to shape a flap about three-quarters of an inch long. In this flap are contained the corpus spongiosum and the urethra.
3. Dissect out the corpus spongiosum from the smaller flap.
4. Divide the corpora cavernosa vertically on a level with the bases of these flaps.
5. Puncture the upper flap so that, when drawn downwards over the face of the stump, the orifice in it will correspond to the position of the urethra. Pass the corpus spongiosum through the opening made in the upper flap, slit up the urethra and corpus spongiosum, and stitch its edges to the margins of the skin incision.
6. Bring the edges of the upper and lower flaps accurately

together with sutures. Mr. Jacobson points out that "this method secures a natural skin covering for the severed corpora cavernosa, and prevents the delay and irritation which the healing by granulation of these bodies entails." The amount of blood lost is also less than in the usual operation.

USUAL METHOD.

In the usual method the root of the penis is compressed by a ligature or by a clamp, the skin is drawn forwards, and the amputation is effected by one sweep of the knife. The urethra is slit up after the profuse hæmorrhage has been arrested. To obviate this loss of blood, Mr. Bryant has made use of the galvanic cautery. The penis is encircled with the cautery wire, which is screwed up pretty tightly. The wire is then heated, great care being taken that the heat should not be too intense, otherwise hæmorrhage ensues. As the wire cuts through the tissues, the *écraseur* is gradually tightened. Then slit up the urethra for half an inch, and stitch its edges to the skin margin. The structures divided in these operations are skin, superficial fascia, which is loose and contains no fat, the united corpora cavernosa with the septum pectiniforme in the median line. In the centre of each corpus cavernosum the artery to that organ is divided.

Lying on the corpora cavernosa is the dorsal vein, with a dorsal artery on either side, and the dorsal nerve outside the artery, and already breaking up into large branches. Accompanying the vein are the lymphatics of the penis. The corpus spongiosum and the contained urethra are divided. The section of the latter is seen to be transversely oval.

REMOVAL OF THE ENTIRE PENIS.

Steps of the Operation.

1. Place the patient in the lithotomy position. Make a median incision along the whole length of the raphé of the scrotum in front surrounding the root of the penis and extending backwards to a point corresponding to the posterior margin of the triangular ligament. You divide in front the dartos, and behind the superficial and deep layers of superficial fascia continuous with it. You expose the penis, with its crura covered by the erector penis muscles, and the bulb covered by the accelerator urinæ. In front the anterior portion of this muscle is seen to surround the whole penis. The suspensory ligament is also seen splitting and enclosing the penis.
2. Pass a sound into the urethra, and dissect out the corpus spongiosum to the anterior layer of the triangular ligament. Remove the sound and cut through the corpus spongiosum, leaving enough of it to allow of its margins being attached to the skin wound.
3. Now cut through the suspensory ligament, ligaturing the dorsal vein and arteries as they pass between its layers.
4. With a raspatory separate each of the crura with the muscle covering from the rami of the pubis and ischium, to which they are very firmly attached, dividing and ligaturing the arteries to the corpora cavernosa.
5. Slit up the urethra and the corpus spongiosum and attach its edges to the margins of the wound in [the perinæum, which you now bring together with sutures. I believe this operation was first performed by Mr. Pearce Gould.

SECTION VII.—LIGATURE OF ARTERIES OF ABDOMEN.

LIGATURE OF THE ABDOMINAL AORTA BELOW THE ORIGIN OF THE SUPERIOR MESENTERIC ARTERY.

Steps of the Operation.

1. Make an incision four inches long down the median line, having its centre at the umbilicus, dividing skin, superficial fascia, and then deep fascia. See Fig. 32.
2. Cut through the aponeurosis forming the linea alba and the transversalis fascia.
3. Stop every bleeding point, and cut through the sub-peritoneal fat and peritoneum, avoiding the suspensory ligament of the liver.
4. Press the small intestines with their mesentery upwards to the right, and expose the aorta covered by a

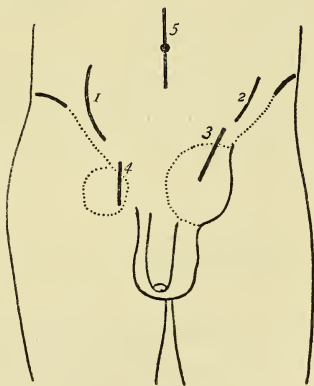


Fig. 32.

1 indicates the incision necessary to ligature the common or internal iliac arteries.

5 that for the abdominal aorta.

single layer of peritoneum, bifurcating half-way down the fourth lumbar vertebra at a point a little to the left of the middle line.

5. Divide the peritoneum covering it, and separate the aortic plexus from its anterior surface, and the aorta from the vena cava, which lies to its right.

Collateral Circulation.

Proximal Branches.

Distal Branches.

Internal mammary, Lower intercostal, and Upper lumbar	} with the	{ Deep epigastric, Ilio-lumbar, Deep circumflex iliac, Superficial epigastric and circumflex iliac, Lower lumbar.
Spermatic	} with the	{ Internal iliac by its branch to the ureter, Artery to the vas deferens.
Sup. hæmorrhoidal	} with the	{ Middle and inferior hæ- morrhoidals.
Ovarian	„	Uterine.

LIGATURE OF THE COMMON ILIAC ARTERY.

Steps of the Operation.

1. An incision similar to that made for ligature of the external iliac is made in this case, except that you continue this one upwards and inwards to a point two inches above and in front of the anterior superior spine. The structures cut through in the muscle wall are also the same as those enumerated in the operation for the external iliac, except that the same muscles are divided to a greater extent

- above, and one or even two more dorsal nerves may be cut through. See page 149.
2. Separate the peritoneum and subperitoneal tissue from the transversalis, and then from the iliac fascia, till you reach the bifurcation of the common iliac on the sacro-iliac synchondrosis. The ureter is pushed off with the peritoneum, as are the meso-rectum and superior hæmorrhoidal vessels.
 3. Carefully divide the sheath of iliac fascia that covers in the artery and vein, and separate the artery from the vein. Also turn inwards the branches of the lumbar sympathetic which pass over the vessel. On the left side, pass your needle first between the artery and the vein, which lies internal to it, and on the right side, first beneath the artery, then between it and the vein, which on this side lies behind it.

Collateral Circulation.

Distal.

Proximal.

Hæmorrhoidal branches of the internal iliac	} with the	{ Superior hæmor- rhoidal artery.
The uterine and vesical of this side	with those of	the opposite side.
The lateral sacral	with the	middle sacral.
Epigastric, deep circumflex iliac, and ilio-lumbar	" "	{ Internal mam- mary, lower in- tercostal, and lumbar arteries.
The internal pudic, the superfi- cial and deep external pudics, epigastric, and obturator ar- teries	} with those of the opposite side.	
Branches to ureter from inter- nal iliac, and artery to the vas deferens	} with the spermatic artery.	
Uterine	" "	Ovarian.

LIGATURE OF THE INTERNAL ILIAC ARTERY.

Steps of the Operation.

1. Make an incision as for ligature of the common iliac, and proceed as you did in that. Fig. 32.
2. Expose the upper part of the external iliac, trace it to the bifurcation of the common iliac, turning off the peritoneum and ureter, and trace the internal iliac downwards into the true pelvis.
3. Separate the artery from the vein, which lies in close contact with its outer surface on the right side, and slightly behind it on the left side. This artery varies usually from an inch to an inch and a half in length.

Collateral circulation is carried on by anastomoses between the—

<i>Distal.</i>		<i>Proximal.</i>
Lateral sacral	and	Middle sacral.
Middle and inferior hæ-	}	{ Superior hæmorrhoidal and
morrhoidals		
Sciatic	„	Profunda.
Gluteal	„	External circumflex.
Obturator	„	{ Fellow of opposite side.
Ilio-lumbar	„	{ Deep epigastric.
Uterine	„	Last lumbar
Ilio-lumbar	}	{ Ovarian.
Gluteal		
Internal pudic	„	{ Superficial and deep exter-
Artery to the vas deferens	„	{ nal pudic and fellow of
		{ opposite side.
		Spermatic.

LIGATURE OF THE INTERNAL PUDIC OR SCIATIC ARTERY. .

Steps of the Operation.

1. Define the upper limit of the tuber ischii. Take a point one inch above it. Make an incision about four inches long in a direction downwards and outwards parallel with the fibres of the gluteus maximus, with its centre corresponding to the point one inch above the tuberosity.

You divide *skin* and *superficial fascia*, with small branches of the *small sciatic*, and of the external branches of the *posterior divisions* of the upper three *sacral nerves*.

2. Divide the deep fascia and the gluteus maximus, with branches of the sciatic artery and superficial branch of the gluteal artery in its substance. Beneath it is seen a layer of deep fascia, not so thick, however, as that superficial to the muscle, and the great sciatic ligament at the posterior extremity of the incision.
3. Cut through this deep fascia and expose the lower border of the pyriformis, and, emerging from under cover of its lower border, the internal pudic artery and veins lying on the spine of the ischium, accompanied by the internal pudic nerve, which lies internal to it, and the nerve to the obturator externus outside it. The artery can now be easily separated from its veins and ligatured. Emerging from under cover of the pyriformis, just outside the pudic, is seen the sciatic artery. It is the larger vessel, and has a direction downwards and outwards, giving off branches, one of which, the coccygeal, may have been divided as it emerges from the great sciatic ligament. It may now be separated from its veins and ligatured. Outside this artery

the small and great sciatic nerves are seen passing downwards from beneath the pyriformis.

LIGATURE OF THE SUPERIOR GLUTEAL ARTERY.

Steps of the Operation.

1. Place the patient on his face. Rotate the thigh inwards. Define the position of the posterior superior spine of the ilium, and the posterior superior angle of the great trochanter. Join these two points by a line drawn with ink on the skin. The junction of the posterior third with the anterior two thirds of this line will, in the majority of subjects, give the position of the artery, as it passes out of the great sciatic foramen between the pyriformis and the bone.
2. Make an incision between four and five inches long in the direction of this line, and having its centre in the given position of the exit of the gluteal artery from the pelvis. You divide *skin, superficial fascia*, thick and tough, and containing branches of the *posterior divisions* of the *two upper sacral nerves and arteries*, branches of the *posterior divisions* of the *three upper lumbar nerves*, branches of the *iliac branch* of the *ilio-hypogastric* and the *lateral cutaneous* of the *last dorsal nerves*. The branches of the last two nerves would only be divided when their area of nerve supply is larger than usual.

Then you cut through *deep fascia*, and beneath it the *gluteus maximus*, with branches of the *superficial division* of the *gluteal artery* in its substance, and entering its under surface. Beneath the *gluteus* you cut through another layer of *deep fascia*, and expose the adjoining borders of the *gluteus medius* and *pyriformis*, and behind

them a portion of the *great sciatic ligament*. Between these two muscles you see the *superficial branch* of the *gluteal artery* emerging.

3. Separate these opposing borders, and trace the superficial branch to the trunk of the vessel, which you see lying between the pyriformis and gluteus minimis, giving off its branches beneath the medius. These branches are seen to be accompanied by the two divisions of the superior gluteal nerve.
4. Hook down the pyriformis still more, and trace the artery to the point where it lies between the pyriformis and the upper margin of the sciatic foramen. It may be necessary to divide some of the free margin of the great sciatic ligament. Separate it from the nerve and ligature it.

LIGATURE OF THE EXTERNAL ILIAC ARTERY.

Steps of the Operation.

1. Make a curved incision with its convexity downwards and outwards, commencing at a point three-quarters of an inch above and a little outside the centre of Poupart's ligament, and ending at a point a little in front and above the anterior superior spine. Fig. 33. You divide *skin* and *superficial fascia*, with cutaneous branches of the *eleventh* and *twelfth dorsal nerves*, and branches of the *superficial external circumflex artery and vein*.
2. Cut through the deep fascia, exposing the aponeurosis of the external oblique crossed by intercolumnar fibres. Above a part of the fleshy portion of the muscle is exposed.
3. Cut through the external oblique, the ilio-hypogastric and ilio-inguinal nerves, and expose the internal oblique, fleshy in all its extent.

4. Divide the internal oblique, the anterior terminal branch of the last dorsal nerve, and possibly the ascending branch of the deep external circumflex artery, both of which lie immediately beneath this muscle.
5. Divide the thin fleshy lamina of transversalis muscle which is now exposed.

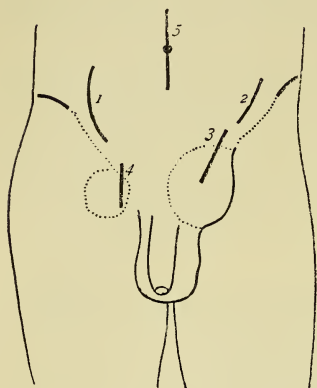


Fig. 33.

2 indicates the line of the skin incision in ligature of the external iliac artery.

6. Divide the transversalis fascia, and separate the peritoneum and subperitoneal fat from the transversalis fascia, till you reach the inner margin of the psoas muscle. Now carefully open the thin layer of fascia that covers the external iliac artery and vein, turning off the genital branch of the genito-crural nerve, if it is seen, and clear the artery, if possible, at a distance from its origin and termination. Pass the aneurism needle between the artery and the vein.

It should be remembered that at its origin the artery is frequently crossed by the ureter, and at its termination by the vas deferens and spermatic artery and vein. In the female the ovarian artery crosses the external iliac below its centre, and the round ligament just above its termination. The deep circumflex iliac vein crosses the artery at its termination.

The circulation in the limb is restored by the anastomoses between the following proximal branches, viz., the internal

mammary and lower intercostal arteries, lumbar arteries, ilio-lumbar, internal pudic, sciatic, obturator, and gluteal arteries, and these distal branches, viz., the deep epigastric, deep circumflex iliac, superficial and deep external pudics, superficial epigastric and circumflex iliac, internal and external circumflex, and perforating branches of the profunda arteries.

In a very fat subject it will be necessary to extend the incision upwards and inwards.

SECTION VIII.—LIGATURE OF VESSELS OF LOWER EXTREMITY.

LIGATURE OF THE COMMON FEMORAL ARTERY.

Steps of the Operation.

1. Make an incision about two and a half inches long, parallel to Poupart's ligament, and about a finger's breadth below it. Its centre must correspond with a vertical line passing through the centre of Poupart's ligament. You divide skin, and superficial fascia consisting of two layers. Between these layers the superficial circumflex iliac and superficial external pudic arteries and veins are cut, also lymphatics from the lower part of the abdomen, and sometimes also from the penis. Lymphatic glands may also be divided in the incision, and branches of the ilio-inguinal and genito-crural nerves.
2. Divide by a short transverse incision the iliac portion of deep fascia covering the vessel, and expose the femoral sheath.
3. Open the sheath over the artery, and clear the artery from the sheath, and from the septum between the artery and the vein. The needle is passed from within outwards.

Collateral Circulation.

Proximal.

Distal.

Branches of internal iliac,

viz. :—

Internal pudic	with the	{ Superficial and deep external pudic arteries.
Gluteal	with the	{ Ascending branches of the external circumflex.
Sciatic and obturator	with the	{ Internal circumflex, transverse and ascending branches of external circumflex, and first and second perforating arteries.

LIGATURE OF THE SUPERFICIAL FEMORAL IN SCARPA'S TRIANGLE.

The superficial femoral is ligatured at the apex of Scarpa's triangle, which is about four inches from Poupart's ligament. See Fig. 34 and Fig. 35.

Steps of the Operation.

1. Make an incision about two and a half inches long over the artery at this point along its length, dividing skin and superficial fascia containing a vein going to join the internal saphena. This must be avoided, or ligatured and divided. Cutaneous branches of the internal cutaneous nerve may be divided also.
2. Divide deep fascia and expose the inner margin of the sartorius. This muscle being drawn outwards, the sheath

of the vessels is exposed. The internal cutaneous nerve is seen crossing it obliquely downwards and inwards. Tear through it in front and expose the artery, which you separate from the vein, which lies immediately behind it. In

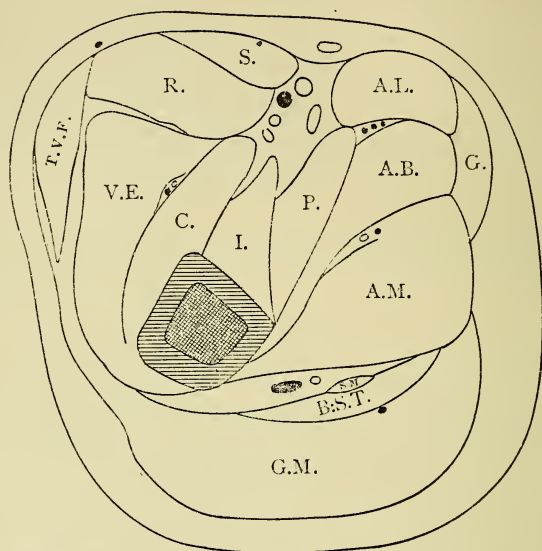


Fig. 34 is a transverse section of the thigh at the level of the point of ligation.

The femoral artery is seen to lie partly under cover of the sartorius, its vein behind and internal to it. The nerves are external to the artery.

The internal saphena vein is seen to lie on the fascia lata, in a superficial and internal relation to the femoral artery.

ligaturing be very careful not to injure the vein. The nerve to the vastus internus and the internal saphenous nerve lie immediately outside the artery. The collateral circulation is the same as that in ligation of the artery in Hunter's canal

LIGATURE OF THE FEMORAL ARTERY IN HUNTER'S CANAL.

Steps of the Operation.

1. The leg being flexed at the knee and thigh and rotated

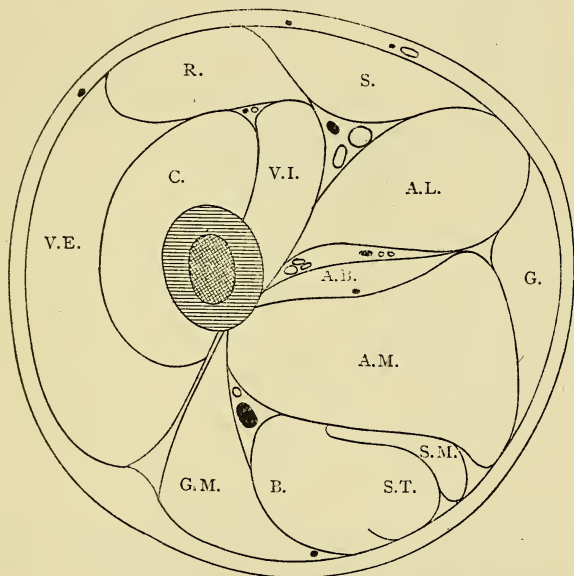


Fig. 35 is a transverse section of the thigh three inches below the lesser trochanter, so that it shows the upper part of Hunter's canal in section.

The femoral artery is seen to lie in it with the vein behind and external to it and the long saphenous nerve external to it.

The canal is bounded by the sartorius, adductor longus, vastus internus, and an aponeurotic expansion which passes from the front of the adductor longus to the vastus. This expansion is not shown in the diagram.

outwards, define the position of the sartorius. This

muscle may often be felt. A line stretching from the centre of Poupart's ligament to the tubercle for the insertion of the adductor magnus will give the position of the artery in the upper and middle thirds of the thigh. See Fig. 35, Fig. 36, and Fig. 37.

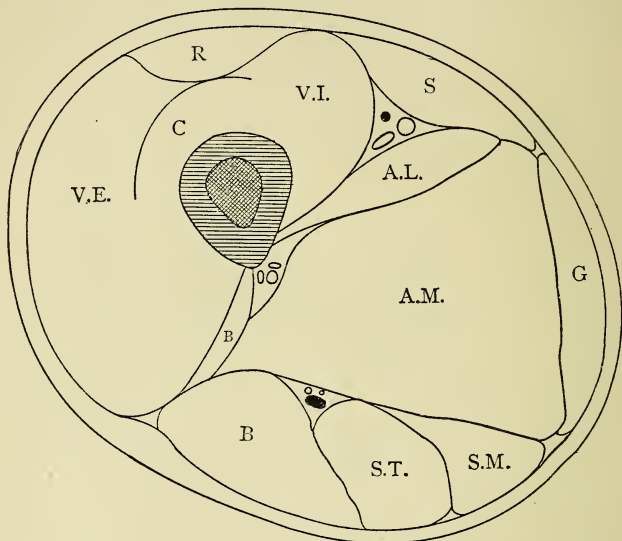


Fig. 36 is a transverse section through the thigh passing through the centre of Hunter's canal, and shows a slight variation in the relative positions of the femoral artery, vein, and internal saphenous nerve.

In this section, as in the preceding, the internal saphenous vein is seen in the superficial fascia superficial to the sartorius.

2. Avoiding the internal saphenous vein, make an incision about three inches long along the inner margin of the sartorius in the middle part of the thigh, dividing *skin*, *superficial fascia*, with branches of the *internal cutaneous* and *middle cutaneous nerves*.

3. Divide deep fascia, exposing the adjoining margins of the sartorius and gracilis, and running along this border of the sartorius the inner branch of the internal cutaneous nerve is seen joining with branches of the internal saphenous nerve.

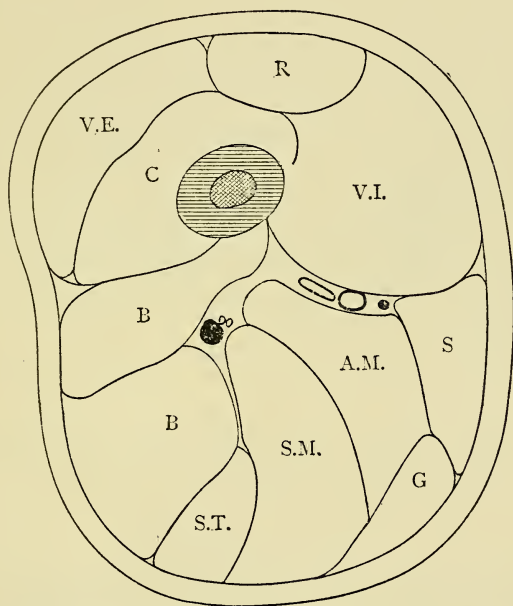


Fig. 37 is a transverse section through the thigh, about three inches above the patella. The section passes through the lowest part of Hunter's canal.

nous and obturator nerves, which emerge from beneath the sartorius.

4. Raise the inner margin of the sartorius, an assistant hooking it outwards. Expose internally the adductor

magnus and adductor longus muscles, externally the vastus internus, and stretching between the two an aponeurotic sheath.

5. Divide this sheath freely and expose the femoral sheath. Opening its inner part, expose the femoral artery. Separate it from the vein, which in the upper part of Hunter's canal lies behind and in the lower part external to it. The internal saphenous nerve lies external to both and is not exposed. The circulation is carried on by anastomoses between the lowest branches of the profunda artery, the descending branches of the external circumflex artery, the comes nervi ischiadici, muscular branches of the femoral above the seat of ligature and the following distal branches, the articular and muscular branches of the popliteal, anterior tibial, and the anastomotica magna arteries.

LIGATURE OF THE POSTERIOR TIBIAL ARTERY IN THE MIDDLE THIRD OF THE LEG.

Steps of the Operation.

1. Define the inner margin of the tibia, and the position of the internal saphena vein. Place the limb on its outer aspect on the table. Make a vertical incision in the middle third of the leg parallel to the inner border of the tibia, and distant from it about a finger's breadth, avoiding the internal saphenous vein. You divide *skin*, and *superficial fascia* containing branches of the *internal saphenous nerve* and *vein*.
2. Divide the deep fascia, and expose the fleshy margin of the inner belly of the gastrocnemius. Hook this outwards,

and expose the fleshy head of the soleus, which arises from the middle third of the inner border of the tibia.

3. Divide this muscle along the extent of the skin incision, cutting through the central membranous tendon contained

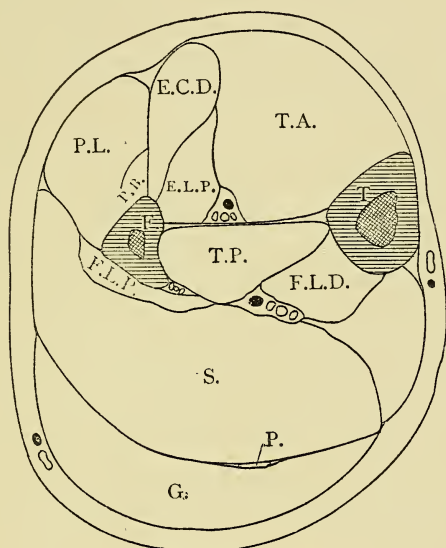


Fig. 38 is a transverse section through the middle of the leg.

The posterior tibial artery, its venæ comites and the posterior tibial nerve are seen lying between the flexor longus digitorum and the soleus.

The nerve in this section lies external to the vessels. The anterior tibial vessels and nerve are seen on the interosseous membrane between the extensor longus pollicis and the tibialis anticus.

in it. Hook the outer portion of the soleus well outwards, and expose a layer of fascia binding down the three deep muscles of the calf.

4. Make an incision into this deep fascia over the artery, which may be felt with its nerve lying beneath it.
5. The artery is exposed, lying in the upper part on the tibialis posticus, lower down on the flexor longus digitorum. It is accompanied by its venæ comites. Above, the nerve lies internal to it, soon becoming posterior and then external to it. The posterior tibial usually gives off the peroneal artery above the portion now exposed.

Separate the artery from the venæ comites and apply a ligature.

The artery may also be tied by a long median incision which divides skin, superficial fascia, deep fascia, gastrocnemius, soleus, and a further layer of deep fascia. It is much more difficult to perform, and the incisions are necessarily longer than in the operation just described.

Collateral circulation is carried on by anastomoses of the dorsalis pedis with the deep branch of the external plantar and termination of the internal plantar; peroneal with the posterior tibial by the posterior communicating branch; external malleolar, tarsal, and metatarsal arteries with branches of the external plantar artery; internal malleolar with the internal calcanean and branches of the internal plantar arteries.

LIGATURE OF THE POSTERIOR TIBIAL IN ITS LOWER THIRD.

Steps of the Operation.

1. Define the position of the inner margins of the tibia and of the tendo-Achilles. Make a vertical incision about two inches long, midway between the inner borders of the tibia and tendo-Achilles, ending at a level of the tip of the inner

malleolus. You divide *skin* and *superficial fascia*, containing branches of the *internal saphenous nerve* and *vein*, and of the *internal calcanean artery*. The *deep fascia* and the *internal annular ligament* continuous with it below is now exposed.

2. Divide the deep fascia, avoiding the sheaths of the tibialis posticus and flexor longus digitorum, whose tendons can be felt distinctly through the deep fascia and annular ligament. Immediately behind them the artery with its *venæ comites* is seen lying on the back of the tibia and ankle joint. The posterior tibial nerve is seen lying external to it. They may both be seen to give off their internal calcanean branches.

Separate the artery from its accompanying veins, and apply a ligature to it.

LIGATURE OF THE ANTERIOR TIBIAL IN ITS MIDDLE THIRD.

Steps of the Operation.

1. A line extending from the inner limit of the head of the fibula to a point midway between the two malleoli will indicate the course of the vessel. Make an incision about four inches long in the middle third of this part of the leg along this line. You divide *skin* and *superficial fascia*, with small cutaneous branches of the *internal saphenous* and *communicans peronei nerves*. You expose *deep fascia*.
2. Examine this deep fascia, and define the white line indicating the attachment of the intermuscular septum between the tibialis anticus and extensor longus digitorum. Cut through the deep fascia along this line, and separate the tibialis anticus from the extensor longus digitorum, at the

same time flexing the foot to diminish tension in these muscles. The extensor longus pollicis is now exposed. Separate it from the tibialis anticus, and expose the anterior tibial artery with its venæ comites lying on the interosseous membrane. The anterior tibial nerve at this point lies usually superficial to the artery. Separate the artery from its accompanying veins, and apply a ligature.

Collateral circulation is carried on by communications between the

Anterior peroneal	and the	{ External malleolar and tarsal arteries.
Internal calcanean	and the	Internal malleolar.
Dorsalis pedis	and the	{ Deep branch of the external plantar and the termination of the internal plantar.

LIGATURE OF THE ANTERIOR TIBIAL IN ITS LOWER THIRD.

Steps of the Operation.

1. Make an incision two inches long immediately to the outer side of the tibialis anticus tendon, dividing *skin* and *superficial fascia*, containing small branches of the *internal saphenous nerve and vein*. Expose *deep fascia*, and lower down *anterior annular ligament*.
2. Make an incision for the same length through the deep fascia immediately outside the tendon of the tibialis anticus, and expose the inner margin of the tendon of the extensor longus pollicis. Between these two tendons, and lying on the tibia, are seen the anterior tibial artery with its venæ comites, and the anterior tibial nerve lying su-

perforial or external to the artery. The artery will be here seen to give off its malleolar branches. Free the artery from its veins, and apply a ligature. The anastomoses are much the same as those given in the operation for ligature of the artery in its middle third.

LIGATURE OF THE DORSALIS PEDIS.

Steps of the Operation.

1. Define the tendons of the extensor proprius pollicis and extensor longus digitorum, and the posterior limit of the first interosseous space. Make an incision two inches long along the outer margin of the tendon of the extensor proprius pollicis, dividing *skin*, and *superficial fascia* containing *small veins*, and branches of the *inner division* of the *musculo-cutaneous* and of the *internal saphenous nerves*. Expose *deep fascia*, and above the *anterior annular ligament*.
2. Divide this deep fascia between the tendons of the extensor proprius pollicis and the extensor communis digitorum, and expose the dorsal artery with its accompanying veins. The inner division of the anterior tibial nerve lies superficial or external to the artery.

At its termination the artery is crossed by the innermost tendon of the extensor brevis digitorum.

SECTION IX.—LIGATURE OF ARTERIES OF HEAD AND NECK.

LIGATURE OF THE INNOMINATE ARTERY.

Steps of the Operation.

1. Place the patient with a pillow beneath his shoulders, and extend his neck, turning the face to the opposite side.

Make an incision about three inches long along the anterior margin of the sterno-mastoid to the episternal notch, and then from the lower extremity of this make another outwards along the upper border of the clavicle.

In the horizontal incision you divide *skin*, *superficial fascia*, and *platysma* containing branches of the *supra-clavicular* and *suprasternal nerves*.

In the other you cut *skin*, *superficial fascia*, a little *platysma* above, branches of the *superficial cervical nerve*, and possibly the *anterior jugular vein* or one of its branches.

2. Divide deep fascia in the anterior incision, and expose the anterior margin of the sterno-mastoid, then in the horizontal incision, where you expose the tendinous head of the sterno-mastoid, a small interval outside it, and then its broad fleshy head.
3. Divide the sternal head and as much of the outer head as you may think necessary, and turn the sterno-mastoid upwards and outwards from the layer of deep fascia beneath

- it. At the same time you may see branches of the superior thyroid artery entering the under surface of the muscle.
4. Avoiding the anterior jugular vein, divide the sterno-hyoid muscle with its fascial sheath along the course of the

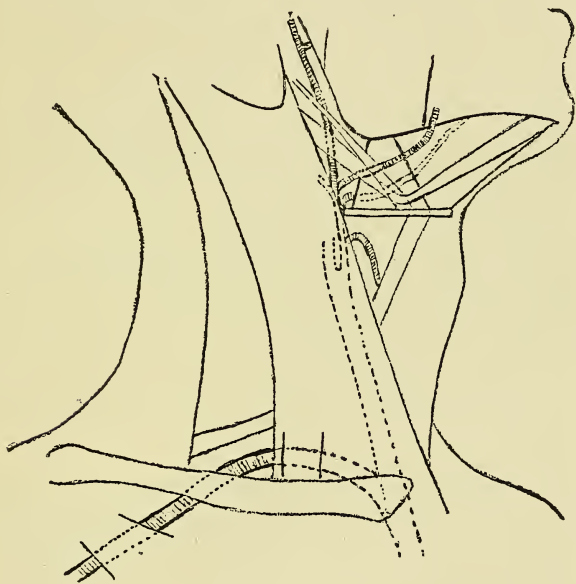


Fig. 39. The dotted double outline indicates the position of the arteries as they lie beneath the various muscles.

- common carotid, and then the broader sterno-thyroid as it lies beneath it. See Fig. 39.
5. Hooking aside these cut margins, expose the sheath of the carotid artery and internal jugular vein. Divide the sheath as much anteriorly as possible, and expose the carotid artery. In doing this avoid any branches of the

ansæ hypoglossi. The internal jugular vein is separated from the carotid at this level on this side by a definite interval, so that its presence causes little trouble.

6. Divide the sheath covering the lower part of the carotid, which you trace to its origin from the innominate artery. Divide as much fascia as you can safely do over the upper and inner aspect of the innominate artery, taking great care to avoid the inferior thyroid veins which pass obliquely downwards over the innominate. Displace the remains of the fascia with the inferior thyroid and left innominate veins downwards, and clear with the finger and director the innominate artery from the pleura which covers its right and posterior aspect, from the vagus which lies on its right side, and from the right innominate vein which covers its right and anterior aspect. Also separate as well as you can the cardiac nerves which run down on the vessel.
7. In ligaturing you must pass the needle between the artery and right innominate vein, and then between the artery and the pleura.

This artery has been ligatured about sixteen times, in only one case successfully, and that case demanded further treatment subsequently. Secondary hæmorrhage is the usual cause of death.

COLLATERAL CIRCULATION.

Proximal Branches.

Aortic intercostals,
Phrenic arteries,
Lumbar arteries,
Deep epigastric

} with

Distal Branches.

{ Superior intercostal,
Internal mammary,
Superior thoracic,
Acromio-thoracic,
Long thoracic,
Subscapular.

Left superior and inferior thyroid and the thyroidea ima	}	with	{	Right inferior thyroid.
Left internal carotid and vertebral	}	with	{	Right internal carotid and vertebral.
Branches of left external carotid	}	with	{	Branches of right external carotid.

LIGATURE OF THE FIRST PORTION OF THE RIGHT SUBCLAVIAN ARTERY.

Ligature of this portion of the artery has never been successfully performed. The greatest objection to its ligature is the shortness of the trunk between its origin and the first branch. In performing this operation it is advisable to tie the artery close to the origin of the vertebral. See Fig. 39.

Steps of the Operation.

1. The shoulder is depressed and the face turned to the opposite side. Make an incision along the inner fourth of the clavicle immediately above its border. Join this by another incision along the anterior margin of the sterno-mastoid. This should be about an inch and a half to two inches long. In these incisions you divide *skin*, *superficial fascia* containing branches of *suprasternal* and *superficial cervical nerves*, and a few fibres of the *platysma*.
2. Divide on a director the sternal head of the sterno-mastoid, and if necessary a small part of the clavicular origin of the muscle.

Hook the sterno-mastoid upwards and outwards. Divide the layer of deep fascia beneath it: the anterior jugular

vein may or may not be divided. The sterno-hyoid muscle is now exposed, and at its inner and outer borders are seen portions of the broader subjacent sterno-thyroid muscle.

3. Divide these muscles and hook them aside, and expose beneath them a layer of deep fascia.
4. Divide this very carefully, and expose the internal jugular vein, on this side separated by a considerable interval from the common carotid, which is felt lying internal to it. It is seen to cross the first portion of the subclavian artery, and to join the innominate vein, which bulges up below and in front of the first portion of the subclavian artery.
5. Press the internal jugular vein outwards, and clear the subclavian artery, avoiding carefully the vagus nerve, which lies beneath the internal jugular, and the recurrent laryngeal nerve, which lies below and behind the subclavian artery; also the sympathetic and cardiac branches which pass over its anterior surface. Clear it also from the pleura, which is in immediate relation with its under surface.
6. Pass the needle between the innominate vein and subclavian artery, then between the artery and the pleura.

After ligature of this vessel the circulation would be carried on by the anastomosis between the

Vertebral artery and its branches	{ with the {	Opposite vertebral, internal carotids, and ascending cervical, &c.
The inferior thyroid artery	{ with the {	Superior thyroid and thyroidea ima of the same side, and the thyroid vessels of the opposite side.

The occipital	} with the {	Superior intercostal, and with the superficial cer- vical arteries.
The intercostal arteries and deep epigastric artery		Internal mammary, supe- rior intercostal, long thoracic, and branches of the subscapular ar- teries.

LIGATURE OF THE INTERNAL MAMMARY ARTERY.

This artery runs behind the costal cartilages of the second, third, fourth, fifth, and sixth cartilages at a distance of about half to three-quarters of an inch from the margin of the sternum. In the majority of subjects, especially female subjects, the artery can be best tied in the second or third space. If the lower chest is large and the gladiolus long, it may be tied in the fourth or sometimes even in the fifth space.

Steps of the Operation.

1. Make a vertical incision from the centre of one cartilage to the centre of the one below it, parallel to the sternum, and about half an inch distant from its outer margin, dividing skin and superficial fascia, deep fascia, perforated by the anterior branches of the intercostal nerves and arteries, and by perforating branches of the internal mammary artery.
2. Divide deep fascia and the subjacent pectoral muscle, then the aponeurotic extension of the external intercostal muscle, and the internal intercostal muscle. You expose the artery with its venæ comites, in the second space lying on the pleura, and in the other spaces upon the triangularis sterni.

The anterior termination of the intercostal nerve is seen to lie in relation with the artery. Separate the veins, carefully avoid the pleura, and ligature.

TO LIGATURE THE VERTEBRAL ARTERY ON THE RIGHT SIDE.

Steps of the Operation.

1. Make an incision about three inches long along the outer margin of the sterno-mastoid to the clavicle, dividing skin, superficial fascia, and platysma. In the superficial fascia and platysma are contained suprasternal branches of the cervical plexus. Deep fascia is exposed, and the external jugular vein is seen passing downwards and perforating the deep fascia. In the upper part of the incision the posterior external jugular vein is seen passing obliquely forwards and downwards to join the external jugular, and in the lower part a communication with the cephalic from the external jugular vein. Ligature the external jugular and divide it.
2. Divide the deep fascia along the margin of the sterno-mastoid muscle, and draw the muscle well inwards, flexing the head a little to diminish tension. In pulling the muscle inwards you expose the layer of deep cervical fascia which passes beneath the sterno-mastoid, and you can see the posterior belly of the omo-hyoid through it. You can feel the scalenus anticus, the vertical inner margin of which you now explore till you reach the prominent tubercle on the transverse process of the sixth cervical vertebra. The phrenic nerve, the transversalis colli, inferior thyroid, and suprascapular arteries are not exposed, as they lie beneath the deep fascia.

3. Scrape carefully through the deep fascia below the tubercle on the transverse process, exposing the internal jugular vein passing downwards parallel to the inner margin of the scalenus anticus. Hook that well inwards, and expose beneath it the vertebral vein, and beneath it the vertebral artery. In most cases it is easier to draw the vertebral vein outwards. The artery is then cleared of the ascending branches from the lower cervical and first thoracic ganglia. The needle is then passed between the vertebral vein and artery. In some cases the vertebral artery may pass through a higher transverse process and the vein through a lower. The inferior thyroid artery may be exposed, passing inwards over the vertebral artery. It may be necessary sometimes to divide the omo-hyoid, should it lie in front of the vessel.

On the right side the presence of the thoracic duct would add very materially to the difficulty and danger of the operation. The duct passes outwards behind the internal jugular vein, lying on the vertebral artery and vein, the inferior thyroid artery, the anterior scalene muscle, the suprascapular and transversalis colli arteries and phrenic nerve. It turns downwards and then inwards.

LIGATURE OF THE INFERIOR THYROID.

Steps of the Operation.

1. Extend the patient's neck by means of a pillow beneath the shoulders, and make an incision three inches long along the anterior margin of the sterno-mastoid to the episternal notch. As in ligature of the common carotid below the omo-hyoid, divide skin, superficial fascia, and contained structures; deep fascia, exposing the anterior margin of

the sterno-mastoid; divide deep layer of deep fascia with the sterno-hyoid and thyroid muscles, exposing the sheath of the carotid vessels: hook the sheath of the carotid vessels outwards, and the trachea and thyroid gland inwards, and expose the inferior thyroid passing forwards from beneath the common carotid artery and entering the posterior surface of the gland. Clear the inferior thyroid from the sympathetic plexus of nerves derived from the middle cervical ganglion, and avoid injuring the ganglion itself, which may lie more internal than usual, when it may be exposed lying on the anterior aspect of the artery. Also take care not to injure the recurrent laryngeal nerve, as it lies between the trachea and œsophagus and usually behind the inferior thyroid artery.

LIGATURE OF THE THIRD PART OF THE SUBCLAVIAN ARTERY.

Steps of the Operation.

1. An assistant draws the shoulder downwards so as to depress the clavicle. The patient's face is turned to the opposite side. Pull the skin down over the clavicle and make an incision through it, cutting on the bone, from the anterior limit of the origin of the trapezius to the posterior limit of the sterno-mastoid, dividing *skin, superficial fascia, and platysma* containing *supra-acromial, clavicular, and sternal branches* of the *cervical plexus*, the communication between the *cephalic* and *external jugular veins* and branches of the *acromio-thoracic* and *suprascapular arteries*. The *external jugular vein* will now be seen perforating *deep fascia* just outside the margin of the sterno-mastoid. Carefully avoid this vein. See Fig. 39.

2. Divide deep cervical fascia along the length of the incision. Should the interval between the muscles be very limited, it is wise to divide a portion of the sterno-mastoid as well, with the process of deep fascia beneath it. You may now expose a plexus of veins formed by the suprascapular and transversalis colli veins, and these may be seen entering the dilated external jugular vein. These veins must be held aside, or if necessary ligatured and cut through. The nerve to the subclavius may be seen passing vertically downwards over the artery, and may be hooked aside.

The omo-hyoid will next be seen to pass obliquely downwards, and immediately below it the brachial plexus and subclavian artery will be seen. The suprascapular artery lies well behind the clavicle and will probably not be seen. The transversalis colli artery may be seen passing beneath the omo-hyoid. The subclavian vein lies below and in front of the artery. Free the artery all round, and pass your needle first between the artery and the vein, then behind the artery, carefully avoiding the cord formed by the eighth cervical and first dorsal nerve. This cord lies immediately behind the artery.

The outer margin of the scalenus anticus may be seen covered by its fascia.

The third part of the subclavian very frequently gives off the posterior scapular artery, and rarely the suprascapular.

After ligature of this vessel the circulation in the arm is carried on by an anastomosis between the suprascapular and posterior scapular arteries with the acromio-thoracic, the subscapular and circumflex arteries; internal mammary and intercostal arteries with the superior thoracic, acromio-thoracic, long thoracic and subscapular arteries.

LIGATURE OF THE COMMON CAROTID BELOW THE OMO-HYOID.

Steps of the Operation.

1. Place a small pillow beneath the neck and shoulders of the patient, turning his face to the opposite side. Define the anterior margin of the sterno-mastoid and the position of the cricoid cartilage.
2. Make an incision along the anterior margin of the sterno-mastoid from a point about half an inch above the level of the cricoid cartilage to the episternal notch. You divide skin, superficial fascia, and perhaps a few fibres of platysma. In this superficial fascia, you cut branches of the superficial cervical nerve, the anterior jugular vein should it pass superficial to the sterno-mastoid, or possibly a communication between it and the external jugular.
3. Divide the deep fascia covering the anterior margin of the sterno-mastoid along the length of the skin incision, exposing the anterior margin of the muscle, and its tendon below, which passes beyond the incision on to the front of the sternum.
4. Divide this tendon and hook the muscle outwards. In doing this branches of the superior thyroid are seen to enter the under surface of the muscle.
5. The layer of deep cervical fascia beneath the sterno-mastoid is now exposed. The sterno-hyoid muscle is seen covered by a sheath of fascia, and lying on the broader sterno-thyroid, whose direction crosses the former obliquely, and whose margin extends on either side of it. Higher up the omo-hyoid is seen, leaving an angular interval between it and the sterno-thyroid.

6. Carefully remove deep fascia from this interval, and expose the carotid sheath, which is continuous with that deep fascia. Crossing it you may see branches of the superior thyroid artery passing to the sterno-mastoid, sterno-hyoid, and thyroid muscles, and often the middle thyroid veins.

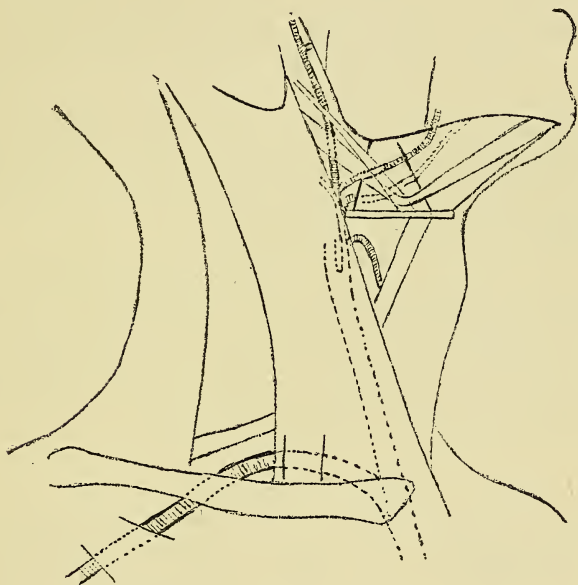


Fig. 40.

- Branches of the ansæ-hypoglossi to the sterno-hyoid and thyroid muscles must be carefully avoided as they lie on the carotid sheath. Should the anterior jugular vein lie higher than usual, it may now be exposed, but in the majority of subjects the anterior jugular lies very close to the clavicle.
7. The omo-hyoid is hooked upwards, and the sterno-hyoid

and thyroid muscles downwards and inwards. The anterior portion of the carotid sheath is opened, and the artery cleared from the sheath, and from the delicate septum between it and the internal jugular vein. This is done with comparative ease on the right side, as the internal jugular at this point is already passing away from the carotid, but on the left side the vein, bulging forwards, overlaps the carotid, and necessitates more skilful separation.

8. The needle is passed first between the vein and artery, and then inwards and forwards beneath the artery, avoiding carefully the vagus nerve. The inferior thyroid artery and the recurrent laryngeal nerve lie behind the artery, but are separated by the carotid sheath from it, and are not likely to be included in the ligature.

Should it be necessary to ligature the carotid lower down, divide the sterno-hyoid, the sterno-thyroid muscles, with their enclosing fascial sheaths in the direction of the course of the vessel, avoiding carefully the anterior jugular vein which crosses them superficially below. Open the sheath and ligature as already described.

Collateral Circulation.

Internal carotid and vertebral,	}	with	{	Internal carotid and vertebral arteries of the opposite side, in the circle of Willis.
Inferior thyroid, and thyroidea ima	}	with		Superior thyroid.
Profunda cervicis,		with		Princeps cervicis.
Superficial cervical,		with		Princeps cervicis.
Superior thyroid, lingual, facial, and occipital arteries,	}	with	{	Vessels of the opposite side.

LIGATURE OF THE COMMON CAROTID ABOVE THE OMO-HYOID.

The common carotid artery bifurcates at the level of the upper border of the thyroid cartilage, and the omo-hyoid crosses it usually at the level of the cricoid cartilage.

Steps of the Operation.

1. The patient being placed on his back, his neck supported by a pillow, and his face turned to the opposite side, define the position of the anterior margin of the sterno-mastoid, the external and anterior jugular veins, the thyroid and cricoid cartilages. See Fig 40.
2. Make an incision along the anterior margin of the sterno-mastoid, from a point half an inch above the level of the upper border of the thyroid cartilage to a point about half an inch below the lower margin of the cricoid cartilage. You cut through skin, superficial fascia, and platysma, containing branches of the inframaxillary division of the facial nerve above, and several branches of the superficial cervical nerve below. The anterior jugular, or a communication between it and the external jugular, may also be cut through.
3. Divide along the length of the skin incision the layer of deep fascia that covers the outer surface of the anterior margin of the sterno-mastoid, and expose the anterior margin of that muscle.
4. An assistant hooks this border well backwards, and the layer of cervical fascia which lies beneath the sterno-mastoid is exposed, and entering the under surface of the muscle branches of the superior thyroid artery, which pass

obliquely downwards and backwards over the common carotid artery.

The omo-hyoid is seen through its sheath of fascia passing obliquely upwards and forwards. You now feel the artery pulsating, or in the dead subject you can feel it rolling between your finger and the vertebral column.

5. Carefully divide deep fascia over the vessel, keeping to its inner side as much as you can. You expose the carotid sheath and branches of the ansæ hypoglossi passing downwards to the omo-hyoid, sterno-hyoid and thyroid muscles. The superior and middle thyroid veins, sometimes also the common facial vein, the lingual and anterior jugular veins are seen passing backwards over the common carotid, with branches of the superior thyroid artery, which have been already seen in their termination in the sterno-mastoid. Should the omo-hyoid cross the vessels higher than usual, it can easily be drawn inwards by a retractor.
6. Divide any veins that require division between two ligatures, open the carotid sheath over the carotid artery, avoiding the internal jugular vein, which bulges forwards, overlapping the artery, especially on the left side, also branches of the descendens noni nerve.

Clear the artery from its sheath and from the septum between it and the vein, and pass the aneurism needle first between the carotid and internal jugular, and then forwards beneath the carotid, keeping close to its wall, so avoiding the vagus nerve, which lies between and internal to the artery and vein.

LIGATURE OF THE INTERNAL CAROTID.

Steps of the Operation.

1. Proceed as in the case of the external carotid (page 180), but instead of opening the carotid sheath over the external carotid, open it over the internal. This vessel can be felt distinctly in the dead subject, and distinguished from the external carotid by its known posterior relation to it. Open the sheath of this vessel as much anteriorly as you can, so as to avoid the internal jugular vein which overlaps the internal carotid: also take care not to divide the descendens noni, which may occasionally lie directly on the internal carotid within its sheath. See Fig. 40.
2. Having exposed the artery, clear it from the sheath between it and the internal jugular posteriorly, and from the vagus, which lies between it and the vein and internal to both. Also turn off any small branches of the glosso-pharyngeal nerve which descend on the vessel. Separate it from the external carotid.
3. Pass the aneurism needle first between the internal jugular vein and internal carotid artery, then between the vagus nerve and the artery, and lastly between the internal and external carotids.

The anastomosis is carried on by the vessels forming the circle of Willis.

By means of the same incision the superior thyroid lingual, facial, and occipital arteries may also be tied. One must remember that the hypoglossal nerve passes outwards between the internal jugular vein and internal carotid artery, that it then passes forwards lying on the internal carotid, occipital, external carotid and lingual

arteries, getting then upon the hyoglossus. In ligature of the facial and occipital the posterior belly of the digastric must be drawn upwards and the hypoglossal hooked downwards.

LIGATURE OF THE EXTERNAL CAROTID.

The external carotid at its origin lies under cover of the sterno-mastoid, it then passes from beneath this muscle vertically upwards across a small triangular interval, which exists between the anterior margin of the sterno-mastoid and the lower border of the digastric, beneath which it then disappears. As a rule, the best point at which the artery can be tied is between the origins of the superior thyroid and lingual arteries.

Steps of the Operation.

1. Place the patient on the back, with a pillow beneath the neck, and the face turned to the opposite side. Define the anterior margin of the sterno-mastoid and the position of the hyoid bone and thyroid cartilage. See Fig. 41.
2. Make an incision along the anterior margin of the sterno-mastoid and parallel to it. The centre of the incision should correspond to a point midway between the upper border of the thyroid cartilage and the great cornu of the hyoid bone. It should be about two inches long. You divide skin, superficial fascia, and platysma containing branches of the superficial cervical, great auricular, and infra-maxillary branches of the facial nerves. The external jugular vein may be exposed in the upper part of the wound, and should, if possible, be turned to one side.

Deep fascia is exposed at the bottom of the wound.

3. Cut carefully through deep fascia and expose the anterior

margin of the sterno-mastoid, which you hook backwards. Beneath it you see a layer of deep fascia, and entering its under surface small branches of the superior thyroid artery.

4. The external and internal carotid vessels can be felt beneath the deep fascia. The fleshy posterior belly of the

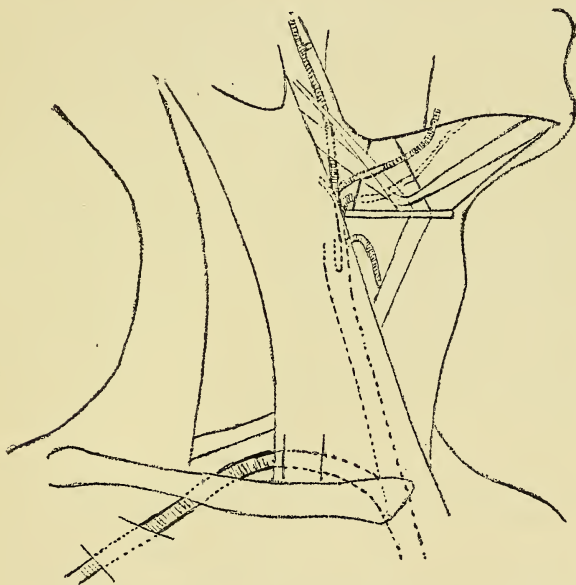


Fig. 41 shows the relations of the external carotid, lingual, facial, and occipital arteries to the surrounding muscles.

digastric muscle may sometimes be seen in the upper limit of the incision, surrounded by its sheath of fascia. Passing backwards over this space are seen the lingual, pharyngeal, and common facial veins, and occasionally the

- superior thyroid veins. These vessels must be hooked to one side if possible, or if not, ligature and divide them. Divide the layer of deep fascia that covers the external carotid, as it here lies anterior and a little internal to the internal carotid, and see it giving off the superior thyroid artery which passes forwards and slightly upwards, and the lingual, which passes upwards and forwards. The hypoglossal nerve is seen crossing the external carotid above the origin of the lingual, and care must be taken to avoid cutting the descendens noni, which lies as a rule behind the external carotid and outside the sheath of the vessels, and the thyro-hyoid nerve, which is immediately in front of it.
5. Clear the external carotid from the surrounding tissues, avoiding any injury to the ascending pharyngeal, which may arise between the lingual and superior thyroid arteries, and to the superior laryngeal nerve which lies internal to it. The circulation is restored by the free anastomoses between the branches of the external carotid with those of the opposite side, with the ophthalmic of the same side, and the princeps with the profunda cervicis.

LIGATURE OF LINGUAL ARTERY.

Steps of the Operation.

1. Place the patient on the back with the head thrown well back and the face turned to the opposite side.
2. Standing behind the patient's head define the several parts of the hyoid bone. Then make an incision one and a half inches long, with a slight downward convexity, commencing just inside the lesser cornu, running outwards just above the greater cornu, and ending on the sterno-mastoid. You divide in so doing skin, superficial fascia, and platysma

with ascending branches of the superficial cervical, and descending branches of the infra-maxillary division of the facial nerves.

3. Now cut through deep fascia above the greater cornu, and expose the lower border of the submaxillary gland. Raise this up and expose the shiny tendon of the digastric muscle. In some cases the common facial or lingual veins may be exposed, and they should, if possible, be pushed aside. (The lingual vein not unfrequently lies on the outer aspect of the hyoglossus.)

Passing beneath the digastric and lying on the hyoglossus is seen the hypoglossal nerve. Hook it upwards.

4. Divide the fibres of the hyoglossus above the border of the great cornu, and expose the lingual artery lying on the middle constrictor, where you ligature it. The posterior margin of the hyoglossus may be defined just above the great cornu of the hyoid bone, and the artery seen passing beneath it. The muscle may then be divided for a varying extent over it. In dividing the hyoglossus you may divide the little hyoid branch of the lingual artery.

In some cases the lingual artery lies a little higher up, sometimes arising in common with the facial artery. In this case you must follow the margin of the hyoglossus still further up. Other variations in the course of the artery are extremely rare.

LIGATURE OF THE MIDDLE MENINGEAL ARTERY.

The anterior division of this artery runs along the inner aspect of the great wing of the sphenoid till it reaches the lower margin of the parietal bone, about half an inch behind the coronal suture. See Fig. 42.

From that point it takes a direction upwards and slightly backwards, so that a line joining the upper margin of the parietal bone one inch behind the coronal suture, and the lower margin, half an inch from the coronal suture, will give the usual course of this branch. This line can be easily defined on the living or dead subject.

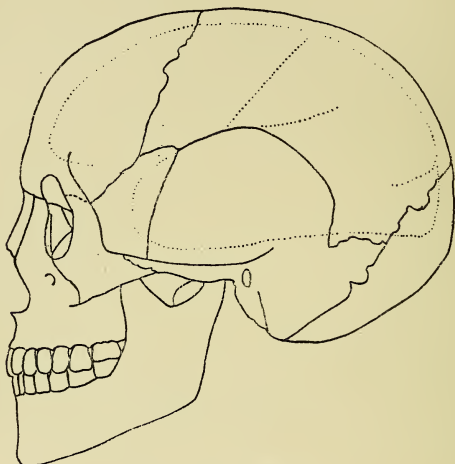


Fig. 42 (*after Thane*).

The dotted line indicates the position of the cerebrum, and of its fissure and lobes.

The sutures are shown as continuous dark lines.

The anterior inferior angle of the parietal bone lies about an inch behind the temporal ridge on the frontal bone at the level of the superciliary ridge, so that a point distant an inch and a half from the temporal ridge at this level gives the position of the artery.

The anterior superior angle of the parietal bone is distant from the root of the nose five inches. This measurement varies

but slightly in different skulls; the variation in the size of different skulls being due to variations in the measurements of the parietal and occipital bones, and not of the frontal bone.

From these measurements we can define the usual course of the anterior branch of the middle meningeal.

Not very rarely the anterior branch runs along the articulation between the frontal and parietal bones. In most heads, the position of the coronal suture may be felt as a slight ridge.

(The line of the Fissure of Rolando runs parallel to this line of the middle meningeal, and about half an inch behind it. This will be referred to again.)

The posterior branch of the middle meningeal passes obliquely upwards and backwards, grooving the squamous portion of the temporal, and the posterior inferior portion of the parietal.

Steps of the Operation for ligature of the anterior branch :—

1. Define the position of the artery as it gets on to the lower margin of the parietal bone by means of the measurements given. Make a crucial incision over it, the centre of the incisions corresponding to the line of the artery. In doing this you divide skin, superficial fascia, and closely connected with it the aponeurosis of the occipito-frontalis, with the attolens aurem arising from it. The anterior division of the temporal artery and vein and branches of the auriculo-temporal and temporo-malar nerves are divided in the superficial fascia. Beneath these in the lower portion of the vertical incision the temporal fascia is cut through, dividing into two layers. The temporal muscle and periosteum are then divided in the crucial incision, and turned off the bone. Branches of the middle temporal artery are divided in its substance, and beneath it branches of the deep temporal arteries, veins, and nerves.

2. Now apply the trephine and remove a circle of bone. This circle will include portions of the frontal, parietal, sphenoid, and squamous portions of the temporal bones.

In using a trephine, first screw the pin so that it projects a slight distance beyond the level of the trephine, and apply it, rotating the instrument till the groove sawn is sufficiently deep to retain the trephine without the presence of the pin. Withdraw the pin, and reapply the trephine. In continuing the sawing you must remember that the bone varies in thickness within the limits of the circle, and that the meningeal artery may be contained in a complete canal or in a deep groove in the bone.

SECTION X.—LIGATURE OF VESSELS OF UPPER EXTREMITY.

LIGATURE OF THE FIRST PORTION OF THE AXILLARY ARTERY.

Steps of the Operation.

1. The position of the axillary artery is defined by abducting the arm slightly from the side, and drawing a line from the centre of the clavicle to the inner margin of the coracobrachialis, where the artery may be felt pulsating in the living subject. See Fig. 41.

Draw the skin slightly upwards over the clavicle, and make an incision along its lower border extending along the middle third or half of the clavicle, dividing *skin*, *superficial fascia*, and *platysma* containing *supra-clavicular*, *supra-sternal*, and *supra-acromial nerves*, a communication between the *cephalic* and *external jugular veins*, and small branches of the *supra-scapular* and *acromio-thoracic arteries*. The *deep fascia* is now exposed, and the *cephalic vein* may in some cases be seen perforating it, but in most cases it lies beneath deep fascia at this part of the arm.

2. Cut through deep fascia, and expose the pectoralis major, the direction of whose fibres are outwards and slightly downwards.

At the outer margin of the pectoralis major the deltoid is seen, and lying between them the cephalic vein and the humeral branch of the acromio-thoracic.

3. Avoiding carefully the cephalic vein, cut through the pectoralis major exposed along the middle third of the clavicle, dividing in its substance branches of the acromio and superior thoracic arteries, and of the external anterior thoracic nerve. Pull down the lower portion of the pectoralis major, exposing beneath it a layer of deep fascia which is attached above to the clavicle behind the pectoralis major, and which passes down, splitting to enclose the pectoralis minor.
4. Divide this deep fascia along the length of the incision, avoiding the cephalic vein. You see the costo-coracoid membrane, thickened above forming the costo-coracoid ligament, and below forming the anterior layer of the sheath of the vessels. Perforating this, you see externally the external anterior thoracic nerve, internal to that the acromio-thoracic artery, which is now seen to divide into the acromial, humeral, and thoracic branches, and more internally the cephalic vein.
5. An assistant hooks downwards the pectoralis minor enclosed in its sheath. Open the sheath of the vessels and you see the axillary vein lying internal to the artery and the brachial plexus external to it. The artery will be seen giving off the acromio and superior thoracic arteries. Separate the artery, and pass your needle first between the vein and artery, then behind the artery, and then between the artery and the brachial plexus. It may be ligatured above or below the origin of these vessels. If above, the collateral circulation is carried on by the same way as in ligature of the third part of the subclavian ; if below, by an anastomosis between the

Acromio-thoracic, Superior thoracic, Suprascapular,	} and the {	Two circumflex arteries,
Posterior scapular, Intercostal and internal mammary		Subscapular artery and its branches, Long thoracic artery, Alar thoracic.

TO LIGATURE THE AXILLARY ARTERY IN THE THIRD PART OF ITS COURSE.

Steps of the Operation.

1. An assistant abducts the arm, rotating it slightly outwards at the same time. Define the position of the artery. The coraco-brachialis can be easily felt, and, in a thin subject, the median and ulnar nerves also. In the living subject pulsation is distinct.

Make an incision two inches long over the artery. This incision will lie nearer the anterior than the posterior fold of the axilla.

You divide *skin* and *superficial fascia*, containing branches of the *intercosto-humeral*, and of the *lateral cutaneous branch* of the *third intercostal nerves*.

2. Divide deep fascia, exposing areolar tissue; in cutting through this you recognize externally the coraco-brachialis and the median nerve, internally the axillary vein and ulnar nerve, and between these structures the axillary artery.
3. Displace the median nerve to the outer side, separate the axillary vein, and displace it with the ulnar nerve to the inside, clear the vessel all round, and pass your aneurism

needle first between the artery and vein, avoiding the musculo-spiral nerve posteriorly and the median nerve externally.

The artery being ligatured below the origin of its branches, the circulation in the arm is carried on by an anastomosis between the same vessels as in ligature of the brachial above the origin of the superior profunda.

LIGATURE OF THE BRACHIAL ARTERY.

1. The brachial artery lies beneath the deep fascia, being superficial in the whole of its extent, except at the bend of the elbow, where it sinks deeply between the supinator longus and pronator radii teres, when it is covered by the bicipital fascia. It lies on the long head of the triceps, the coraco-brachialis, and the brachialis anticus. To its outer border it has above the margin of the coraco-brachialis, and below the margin of the biceps, both these muscles sometimes overlapping it somewhat. It is crossed from without inwards about its centre by the median nerve. In the living subject the artery may be felt pulsating in the whole of its course. See Figs. 43, 44.

TO LIGATURE THE ARTERY IN THE LOWER TWO THIRDS OF ITS COURSE.

1. Define the position of the inner margin of the biceps, and that of the brachial artery in the living subject by feeling its pulsations, also the basilic vein. See Figs. 43, 44.
2. Make a longitudinal incision about two or three inches long

along the inner margin of the biceps, avoiding the basilic, and, in the bend of the elbow, the median basilic veins, dividing *skin*, and *superficial fascia* containing *cutaneous*

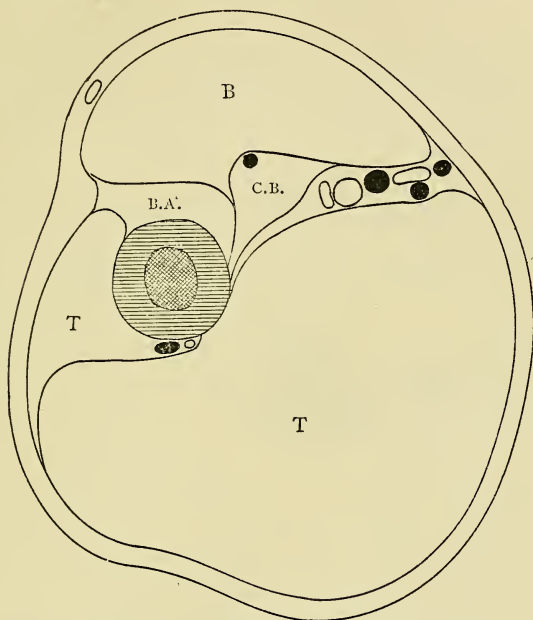


Fig. 43 is a transverse section through the centre of the upper arm. It shows the relation of the brachial artery in this region to the neighbouring structures.

The brachial artery and vein are seen as they lie between the biceps, coraco-brachialis, and triceps muscles, and the ulnar, median, internal cutaneous nerves, and the basilic vein, as they lie internal to the brachial vessels.

branches of the internal cutaneous, lesser internal cutaneous, and intercosto-humeral nerves.

3. Divide deep fascia, and the bicipital fascia, if the artery is to be ligatured in the bend of the elbow.

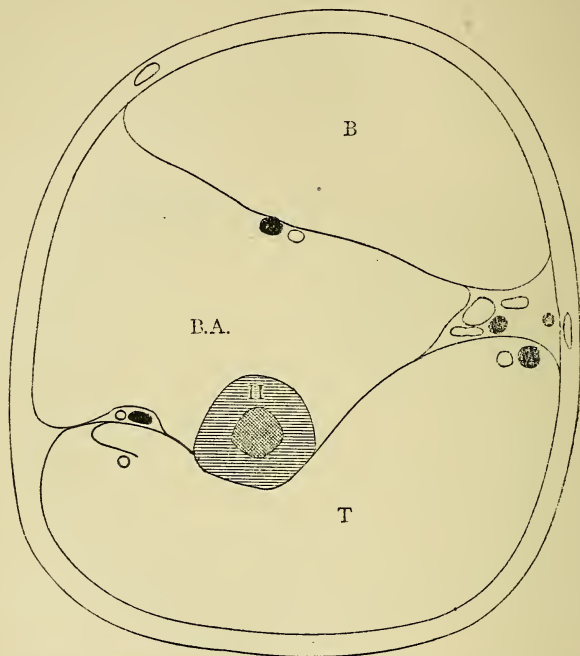


Fig. 44 is a transverse section through the centre of the lower third of the upper arm.

The brachial artery with its venæ comites, the median and internal cutaneous nerves are seen as they lie between the biceps, brachialis anticus, and triceps.

The ulnar nerve and inferior profunda artery lie behind the internal intermuscular septum; the inferior profunda artery and musculo-spiral nerve between the brachialis anticus and triceps.

4. Expose the brachial vessels in their sheath, with the median nerve lying superficial to it in the centre of the arm, but

somewhat internal to it lower down. The ulnar nerve with the superior profunda artery, lying internal to the vessels in the centre of the arm, may also be exposed.

5. Open the sheath, separating the *venæ comites* from the artery and ligature.

In the lower two thirds of its extent the inferior profunda, nutrient, and anastomotica magna arteries are given off from the brachial.

TO LIGATURE THE BRACHIAL ARTERY IN THE UPPER THIRD OF ITS COURSE.

Steps of the Operation.

1. Abduct the arm and rotate it outwards. Carefully define the inner margin of the coraco-brachialis, on the inner margin of which the brachial artery may be felt pulsating in the living subject.
2. Make an incision about two and a half inches long just internal and parallel to the inner margin of the coraco-brachialis. In some rare cases the basilic vein does not perforate the deep fascia in the lower two thirds of the arm. In these cases avoid the vein in your incision. In the superficial fascia you divide cutaneous branches of the internal cutaneous and of the intercosto-humeral nerves.
3. Divide deep fascia and expose the sheath of the vessels. The median nerve lies to its outer side; the ulnar and internal cutaneous lie to its inner side.
4. Open the sheath, and expose the artery with its *venæ comites*. In many cases the basilic vein will have already united with the *venæ comites*, while in others it runs up beneath the deep fascia, and joins the *venæ comites* to form on the latissimus dorsi the axillary vein.

5. Separate the artery from the veins, and ligature it.

When the brachial artery is ligatured above the origin of the superior profunda the circulation is carried on by an anastomosis between the

Muscular branches of the brachial to the coraco- brachialis and biceps; muscular branches of the superior profunda to the deltoid, coraco- brachialis, and triceps,	and the	Branches of the anterior circumflex to the biceps and coraco-brachialis; branches to the deltoid and triceps from the posterior circumflex and the dorsalis sca- pulæ arteries.
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When the brachial is ligatured above the anastomotica magna and below the superior profunda, the circulation is carried on by an anastomosis between the

Superior profunda, by branches which pass behind the inner and outer condyles and in front of the outer, also by the posterior arti- cular branch: the in- ferior profunda, by branches passing in front and behind the inner condyle,	and the	Anastomotica magna, Radial recurrent in front of the outer condyle, Interosseous recurrent behind outer condyle, Anterior ulnar recur- rent in front of inner condyle, Posterior ulnar recur- rent behind internal condyle.
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If the brachial artery is ligatured below the anastomotica magna, the same anastomosis takes place as in this list, except that the anastomotica branches must be removed from the right-hand list and placed in the left-hand list of vessels. It has three branches, one in front and one behind the internal condyle, and one behind the external condyle.

TO LIGATURE THE ULNAR ARTERY IN THE LOWER HALF OF ITS COURSE.

Steps of the Operation.

1. The artery here lies immediately outside the outer free

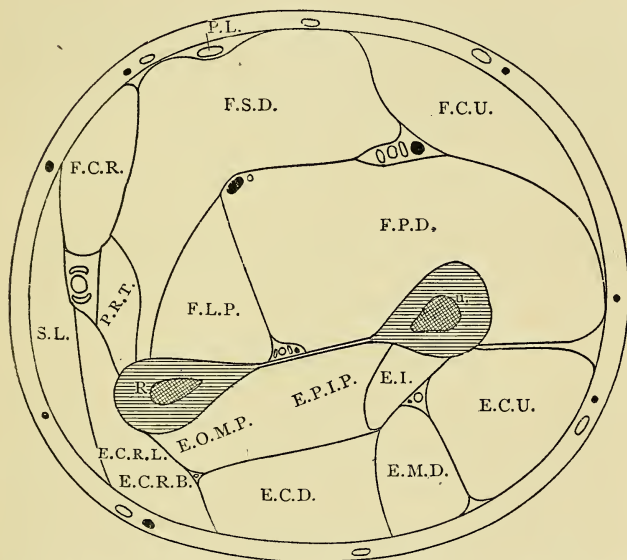


Fig. 45 is a transverse section through the centre of the forearm. It shows the ulnar and radial arteries and their relations to neighbouring structures in this portion of their course.

margin of the flexor carpi ulnaris, which margin can be felt distinctly in the dead or living subject. It has to its outer side the flexor sublimis digitorum, and lies on the

flexor profundus digitorum. The ulnar nerve lies to its inner side. See Fig. 45.

The artery can be felt to pulsate in the living subject.

2. Having defined the position of the artery, make an incision an inch and a half long, or longer if necessary, over its course, dividing skin and superficial fascia containing branches of the internal cutaneous nerve and ulnar vein.
3. Divide deep fascia, exposing the outer margin of the tendon of the flexor carpi ulnaris, and in the middle of the forearm the flexor sublimis, the ulnar nerve, and the ulnar artery with its venæ comites.
4. Separate the venæ comites and ligature.

TO LIGATURE THE RADIAL ARTERY IN THE UPPER THIRD OF ITS COURSE.

Steps of the Operation.

1. The artery takes in this part of its course a direction obliquely downwards and outwards from the inner aspect of the tendon of the biceps to the inner margin of the supinator longus at the junction of the upper third with the lower two thirds of the forearm, continuing the direction of the brachial artery. It rests on the tendon of the biceps, on the supinator brevis, and on the upper part of the insertion of the pronator teres. In the living subject it may be felt to pulsate distinctly.
2. Having defined the exact position of the artery, make an incision two inches long over it, dividing skin, superficial fascia with branches of the anterior division of the external cutaneous nerve and of the radial and median veins.

3. Divide deep fascia and expose the artery with its venæ comites. It may be seen to give off the radial recurrent.
4. Separate the venæ comites and apply a ligature.

TO LIGATURE THE RADIAL ARTERY IN THE MIDDLE THIRD OF THE FOREARM.

Steps of the Operation.

1. The artery here takes a vertical course, lying just internal to the tendon of the supinator longus below, while above it is slightly overlapped by the fleshy portion of the muscle. Behind it rests on the insertion of the pronator teres above, and the origins of the flexor sublimis and pollicis below. The radial nerve lies external to it in this part of its course. It may also be felt to pulsate distinctly in the living subject. Having defined its position, make an incision two inches long in the course of the vessel, dividing skin and superficial fascia with branches of the anterior division of the radial vein and external cutaneous nerve. See Fig. 45.
2. Divide the layer of deep fascia now exposed, separate the muscles which overlap it, and you see the radial artery with its venæ comites. The radial nerve may be seen lying to its outer side.
3. Separate the venæ comites from the vessel and ligature it.

LIGATURE OF THE RADIAL ARTERY IN THE LOWER THIRD OF THE FOREARM.

Steps of the Operation.

1. The radial artery, accompanied by its venæ comites, in this part of its course lies on the flexor longus pollicis, pro-

nator quadratus, and the radius, at a distance from the extremity of the styloid process of the radius varying from half to three-quarters of an inch. It has to its inner side the tendon of the flexor carpi radialis, and to its outer side the supinator longus. Having by these means defined the position of the artery in the dead subject, or rendered it more accurate in the living subject by feeling it pulsate, make an incision an inch and a half long over its course, cutting through skin, and superficial fascia with branches of the radial vein and the external cutaneous nerve.

2. Then divide deep fascia and expose the vessel with its *venæ comites*. Separate these and apply a ligature to the vessel.

LIGATURE OF THE RADIAL ARTERY ON THE WRIST.

Steps of the Operation.

1. After the radial artery leaves the anterior margin of the lower end of the radius it passes obliquely outwards and downwards on the wrist, lying on the scaphoid, external lateral ligament of the wrist, trapezium, and bases of the first and second metacarpal bones. It passes beneath the tendons of the extensor ossis and primi internodii pollicis, and then beneath that of the extensor secundi.
2. Having defined the position of the artery, make a vertical incision one inch and a quarter long behind and parallel to the tendons of the extensor ossis and the extensor primi internodii pollicis, its centre crossing the radial artery. In doing this you divide skin and superficial fascia with branches of the radial vein and external cutaneous nerve.
3. Divide the deep fascia, and expose the artery with its

venæ comites and accompanied by a small branch of the external cutaneous. It may be seen giving off the dorsalis indicis and pollicis, the posterior carpal and the meta-carpal branches.

4. Separate the venæ comites and ligature.

TO LIGATURE THE SUPERFICIAL PALMAR ARCH.

Steps of the Operation.

1. The hand being in the supine position, and the thumb in a position of abduction, draw with ink on the palm a line extending from the lower border of the root of the thumb inwards across the palm to the junction of the inner with the outer two thirds of its anterior surface, and passing then obliquely upwards and inwards to a point just outside the pisiform bone. The easiest point at which this arch can be ligatured is in the oblique portion, as here no strong layer of deep fascia has to be cut through, and because the artery can at this point be felt pulsating distinctly in the living subject. See Fig. 46.



Fig. 46 is a diagram of the palm of the hand.

2. Make an incision an inch and a half long, extending from a point just above and outside the pisiform bone, and running downwards with a slight inclination outwards, dividing skin, superficial fascia, containing small branches of veins, of the internal cutaneous, and the palmar cutaneous of the ulnar nerves. In the upper part of the incision the ulnar artery

is seen or felt lying superficial to the annular ligament, and, with the ulnar nerve which lies internal to it, covered by a layer of deep fascia.

The superficial arch is exposed at its origin by dividing the deep fascia which covers it in, when it is seen to be the direct continuation of the ulnar artery. The superficial division of the ulnar nerve is seen lying inside and beneath the artery.

This arch is ligatured in the majority of cases for a wound dividing it, when the cut ends are got at by extending the incision, and picking them up in the wound already made.

In a large number of subjects the superficial palmar arch unites with the *radialis indicis* or the *princeps pollicis*, so that in these cases ligature of the superficial branch of the ulnar artery would affect but slightly the circulation in the superficial arch.

SECTION XI.—OPERATIONS FOR THE DIVISION OF BONES, MUSCLES, AND TENDONS.

DIVISION OF THE STERNO-MASTOID.

1. In very young children this muscle is most easily divided in its centre.

Pick up the sterno-mastoid at its centre between the thumb and forefinger of the left hand, and pass the point of a sharp tenotome with its blade parallel to the surface of the muscle beneath the muscle from without inwards till the point is felt by the index finger beneath the skin.

2. Turn the sharp edge of the knife towards the muscle, and withdraw the knife gradually, dividing the muscle completely as you do so. You must not remove the forefinger till you begin to remove the knife, when you follow with it the retreating point of the knife, and so insure the complete division of the muscle.

In this operation the internal jugular vein is the structure beneath the muscle which is in most danger of division, especially as it becomes distended with blood should the infant struggle. Messrs. Little speak very favourably of the division of the muscle in this situation (Holmes's System, vol. ii., "Orthopædic Surgery). After

the operation you apply, as in other tenotomies, a pad of lint and strapping to the puncture in the skin.

Not uncommonly the sternal portion of the muscle alone requires section. This is best done about half an inch above the upper margin of the manubrium, care being taken to avoid the anterior jugular vein. An assistant holds the head, so that the tendon is tense and prominent. You then insert the point of a tenotomy knife, its blade being parallel to the surface, beneath the inner margin of the tendon, and carefully following the posterior surface of the tendon with the point till it reaches the interval between the two heads, where it can be felt beneath the skin by the finger. Still retaining the finger in position, turn the edge of the knife against the tendon and divide it.

Should the clavicular head also require to be divided, you pass the blade of the knife from without inwards, beneath the rigid band of muscle, as in the two last instances. You avoid the external jugular vein as you enter the point of the knife, and the internal jugular vein as you pass inwards behind the muscle.

Similar precautions apply to the section of tendons, muscles, and contracted bands of fascia in other parts of the body.

EXTERNAL STRABISMUS.

DIVISION OF THE EXTERNAL RECTUS.

Steps of the Operation.

1. Fix a stop speculum between the lids. Pick up the conjunctiva and subconjunctival tissue with toothed forceps at a point just below the lower margin of the tendon of the internal rectus at its insertion. This point will cor-

respond to the level of the lower margin of the cornea, and be distant from the corneal margin about four lines. Snip through the conjunctiva and subconjunctival tissue with narrow straight blunt scissors, making a short incision.

2. In this opening the capsule of Tenon is exposed. Pick this up, and snip it through in a similar way with the scissors.
3. The sclerotic is now exposed. Pass a strabismus hook with its blunt end directed upwards and its concavity resting on the sclerotic. Sweep this upwards and forwards towards the cornea, and, if you are beneath the tendon, you feel the further passage of the instrument stopped at the insertion of the rectus.
4. Having caught the tendon, hold the hook in the left hand, raising the tendon. Insert one blade of the scissors beneath the tendon between it and the globe, and the other outside the tendon. Snip through the tendon and its aponeurotic expansion. The hook will now pass on to the margin of the cornea.

The internal rectus may be divided in a similar manner.

TENOTOMY IN TALIPES VARUS.

In cases of varus requiring tenotomy, it may be necessary to divide the tibialis posticus, tibialis anticus, and the tendo-Achilles, and it is in this order that these tendons should be divided if it is considered necessary to divide all these at the same time. It is frequently advisable to leave the section of the tendo-Achilles till the sole of the foot has been unfolded.

TO DIVIDE THE TIBIALIS POSTICUS.

1. Define, if possible, the posterior margin of the tibia, about three-quarters of an inch above the extremity of the inner

malleolus. In the very young subject this is very difficult to find, but it will be defined as being placed midway between the anterior and posterior margins of the leg at this level. An assistant holds the foot so as to render the tendon tense.

2. Enter the point of a sharp-pointed tenotomy knife between the tibia and the tendo-Achilles, holding the blade parallel to the surface of the bone. By pressing forwards with the blade you can assure yourself that the knife is between the tendon and bone. Now alter the direction of the edge of the knife so as to direct it backwards, and make slight pressure against the tendon, which you feel yield with a snap.

The tendon of the flexor longus digitorum is sometimes partially or completely divided, and if care be not taken to avoid introducing the knife too far, the posterior tibial artery and veins may also be divided. It is, however, very rare for any troublesome consequences to follow section of this artery. The bleeding which occurs at the time is easily controlled by a small pad and strapping. By some surgeons the tendon is divided at its insertion into the tubercle of the scaphoid.

TO DIVIDE THE TIBIALIS ANTICUS.

1. An assistant holds the foot so as to render the tendon tight. Insert the point of a tenotomy knife beneath the tendon where it lies in front of the ankle. When the knife is felt well beneath the tendon, turn its edge against it and divide it, taking care not to cut the skin.

In a bad case of talipes varus, as Messrs. Shattock and Parker have shown ("Transactions of the Pathological Society, 1885"), the deformity is much diminished by dividing that portion of the internal lateral ligament of

the ankle joint that is inserted into the tubercle of the scaphoid.

In a bad case of acquired talipes, which required the removal of a portion of the tarsus, I obtained a great improvement in the movements of the foot by removing the tibialis anticus from its insertion into the internal cuneiform and first metatarsal, stitching it to the dorsal aspect of the bases of the fourth and fifth metatarsal bones.

TO DIVIDE THE TENDO-ACHILLES.

1. Place the patient on the face. An assistant holds the foot so as to make the tendo-Achilles prominent.
2. Pass a tenotome in front of the tendon, alter the direction of the edge of the knife, and cut backwards, at the same time keeping a finger on the skin to prevent any possibility of its being punctured.

OGSTON'S OPERATION.

1. Flex the knee completely. Introduce the point of a long tenotomy knife with the blade flat on the anterior and inner aspect of the thigh, two or three inches above the inner condyle. Pass it forwards, downwards, and outwards till you feel the point in the groove between the two condyles.

Turn the edge of the knife downwards, and as you remove it cut a channel large enough to admit the blade of an Adams' saw.

Introduce the saw, and divide the inner condyle through three-quarters of its thickness.

You will then be able to break through the remainder of its thickness by forcibly adducting the extended leg on the thigh.

MACEWEN'S OPERATION FOR GENU VALGUM.

Steps of the Operation.

1. Remove the blood from the limb, either by an Esmarch's bandage or by holding it vertically for some time, and apply an elastic tourniquet. Bend the knee, and rest its outer aspect on a sand-bag about half full of sand.
Define the position of the tendon of the adductor magnus and its tubercle.
2. Make a longitudinal incision upwards, about two inches long, from a point about three-quarters of an inch above the adductor tubercle, and half an inch in front of the adductor magnus, cutting at once to bone.
3. Before removing the knife, pass the osteotome along its surface till it reaches the bone, when you turn its edge from the vertical to a transverse direction, avoiding the forcible removal of the periosteum in doing this.
4. So direct the osteotome that it will cut from behind forwards and outwards, and then divide the anterior and inner portions of the bone. Alter the direction of the osteotome, so that it may cut backwards and outwards towards the posterior and outer aspect of the femur. (This is necessitated by the fact that, at the line of section, the femur is much deeper externally than internally.)

In completing the section, should the bone be dense, it is advisable to remove the larger osteotome and insert a smaller one. The remaining margin of bone may be broken by forcibly abducting the leg. It is then dressed and placed in a splint, which has a posterior support for the leg, and whose outer portion is carried up like a long splint into the axilla.

In this operation you divide skin, superficial fascia containing branches of the internal cutaneous nerve, deep fascia, vastus internus, and periosteum. Branches of the *anastomotica magna* which pass outwards over the anterior surface of the femur may be divided, but the trunk of this vessel lies directly on the tendon of the adductor magnus. The branch of the nerve to the vastus internus that goes to the knee joint may be cut.

The synovial lining of the joint is not opened, as its posterior layer is here but loosely connected to the bone by areolar tissues. The popliteal artery is separated from the femur by an interval containing fat. Risk of injury to these two structures is diminished by flexing the knee. See Fig. 8.

In England the femur is usually divided with a key-hole saw instead of by the chisel. With a long-pointed narrow-bladed knife, a small incision is made through the skin and subjacent structures down to the bone, usually at the same point as that in which the vertical incision in MacEwen's operation is made. On reaching the inner aspect of the bone, the knife is passed on over its anterior aspect, and this surface cleared by cutting through the periosteum and adjacent soft structure to allow of the direct application of the saw to the bone. The saw is then introduced and the femur cut through from before backwards. The section is not usually allowed to extend completely through the bone, the remaining portion of its posterior wall being broken as soon as it is sufficiently thin to yield to moderate pressure. The same principle of transverse section by the saw or chisel is applied to rectify anterior or lateral curves of the tibia, and in some cases of anterior curvature of the tibia you remove a triangular wedge of bone whose base forms part of the convexity of the curve. By far the most

scientific treatment of anterior or lateral curves of the long bones is one devised by Mr. Gowan. The following description, with which he has furnished me, elucidated by his diagrams will explain to the reader its advantages.

OBLIQUE SECTION OF THE AFFECTED BONE.

If the deformity of the long bone be a lateral one, that is, if the bowing of the bones forms a *convexity* whose *direction* is *inwards* or *outwards*, then the *plane of section* of the affected bone should *pass downwards and backwards* at an *angle of not greater than 35° to 40° with the shaft*, but if the deformity be an *antero-posterior* one, then the *plane of section* should *meet the antero-posterior plane passing through the axis of the bone* at an *angle of not greater than 35° to 40°*. The simplicity of this method can be easily demonstrated by making an oblique section through a curved twig of wood, keeping the point of the knife towards the centre of the curve. The relative positions of the two extremities of the curved twig may then be materially altered with a *minimum of displacement at the point of section*, where the cut surfaces simply glide on one another, and do not leave any gap to be subsequently filled in by callus.

Mr. Gowan is bringing out an osteotome, by means of which the section of the bone can be easily effected through an incision, which is not larger than that made for the introduction of the key-hole saw.

Figs. 47, 48, 49, and 50, show diagrammatically the application of this method to a tibia and fibula in which the tibia presents a marked internal convexity.

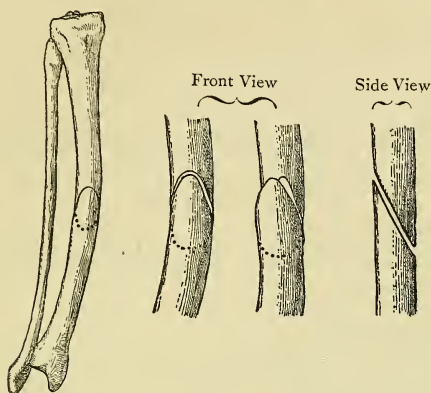


Fig. 47. Fig. 48. Fig. 49. Fig. 50.

Fig. 47 represents a front view of a tibia and fibula, the former showing a marked lateral deformity. The firm curved line crossing the bone near its centre shows the upper angle of the section. The dotted line indicates the lower angle, and has a somewhat shallower curve owing to the flatness of the posterior aspect of the bone.

Fig. 48, drawn to a larger scale, represents the same bone at and about the seat of section.

Fig. 49 represents the same bone after the articular ends and the point of section have been brought into one and the same straight line. It shows also how little disturbance of the cut surfaces is necessary to effect this correction, the total amount of displacement being a little more than the area included between the two curved lines at the right side of the figure.

Fig. 50 is a side view of the bone, the anterior border facing to the left. The line of section is seen to form an angle of about 35° with the long axis of the bone.

N.B.—Except in EXTREME cases it is unnecessary to cut or break the fibula.

SECTION XII.—OPERATIONS FOR HARE-LIP AND CLEFT PALATE.

The soft palate consists of the following structures from before backwards :—

1. Mucous membrane.
2. A thick layer of submucous tissue, consisting chiefly of lymphoid tissue, and covered on its anterior surface by the thin plane of the palato-glossus muscle.
3. The tendon of the tensor palati turns inwards around the anterior surface of the hamular process, which can be felt to be situated just inside and behind the tuberosity of the superior maxilla. From this point the aponeurosis spreads inwards, increasing enormously in extent. It blends with its fellow of the opposite side, and is attached above to the ridge on the under surface of the palate bone. Between the hamular process and the superior maxilla is the posterior palatine foramen, from which the descending palatine vessels emerge, and by the occlusion of which hæmorrhage has been controlled.
4. The anterior layer of the palato-pharyngeus muscle, the fibres of which are directed outwards and downwards. Behind this
5. The levator palati passes in a direction obliquely downwards, forwards, and inwards, its lowest fibres ending in the uvula. Behind it lies

6. The azygos uvula, which arises from the posterior nasal spine and terminates also in the uvula.
7. The posterior layer of the palato-pharyngeus covers these two muscles on their posterior aspect.
8. Submucous tissue and mucous membrane.

The hard palate is formed by the palate processes of the superior maxillary and palate bones. It is covered on its inferior aspect by periosteum and mucous membrane, which are closely united to one another, but which are separated from the bone as a muco-periosteal flap with comparative facility.

The descending palatine artery emerges from the posterior palatine foramen with the palatine nerve. It runs forwards lying in a groove in the bone, and ends in a small vessel, which ascends through the incisor foramen, and anastomoses with the artery of the septum. It sends twigs to the anterior surface of the soft palate while in the posterior palatine canal.

The ascending palatine branch of the facial sends a twig which accompanies the tendon of the tensor palati and supplies the anterior surface of the soft palate.

The palatine branch of the ascending pharyngeal artery accompanies the levator palati to the soft palate. It divides into an anterior and a posterior twig, both of which unite with corresponding branches of the opposite side.

CLEFT OF THE SOFT PALATE—STAPHYLORAPHY.

Steps of the Operation.

1. The child's head is so arranged that it hangs sufficiently downwards to prevent the blood running into the lower

part of the pharynx and into the mouth, but into the upper part of the pharynx instead.

Separate the jaws thoroughly by a gag. I have found Gowan's spiral gag more useful than any other for this purpose. If necessary an assistant lights up the cavity of the mouth with an electric light or reflected light.

2. Grasp the lower extremity of the fold on one side with the forceps, and remove the mucous membrane and submucous tissue where it covers the free margin of the cleft. This you do by passing the point of a long, narrow, double-edged knife vertically through it and cutting upwards and downwards.

Treat the opposite fold in the same way. Do not detach the mucous flaps from their upper attachments, but, if possible, remove them with the mucous membrane covering the angle of the cleft entire, so that the portion removed is single and undivided. By this means you make sure that every portion of the cleft has been thoroughly deprived of its mucous covering.

3. Grasp each division of the uvula with the forceps, making each flap tense, and using a long narrow knife, enter its point a little inside the hamular process, and cut vertically through the soft palate till you consider you have divided both the levator and tensor palati.
4. Use curved needles placed at right and oblique angles to the shaft with which they are continuous, and grasping the uvula of the left side, pass a suture through this flap from before backwards near the incised margin. Then grasp the opposite uvula, making the flap tense, and pass the needle through it from behind forwards. The suture is now picked off the needle, and held while the needle itself is withdrawn from the wound. Having passed a sufficient number of sutures, tie them from below upwards, carefully adjusting the opposing margins.

Should much difficulty be experienced in closing the upper part of a cleft in the soft palate above, or should the cleft extend for a short distance between the palate bones, the vertical incision must be extended upwards and forwards for a short distance on the hard palate. The muco-periosteum between this incision and the free margin of the cleft is freed from the bone by a separator, the muco-periosteal flap being separated from without inwards. The tensor palati, two layers of the palato-pharyngeus, the azygos uvulæ, the mucous membrane and submucous tissue covering the posterior surface of the palati are cut through at their attachments to the hard palate by a pair of curved scissors introduced through the vertical incision on either side.

CLEFT OF THE HARD AND SOFT PALATE.

Some surgeons prefer to operate on the hard and soft palate at different times, while others, as Mr. Pollock, consider that the operation should be completed at one sitting.

Steps of the Operation for Closing a Cleft in the Hard Palate.

1. The head is placed in the same position as in the last described operation, and a gag introduced. Pare the edges of the cleft.
2. Make a lateral incision through the muco-periosteum covering the under surface of the hard palate parallel and close to the alveolus. The length of these incisions and their proximity to the alveolus varies in proportion to the extent of the cleft. It should be sufficiently long to allow of the muco-periosteum intervening between it and the cleft being separated from the bone.

3. This you proceed to do, using a small raspatory called a separator. The inner edges of the flaps should now meet in the median line, and as in the last operation, the remaining layers of the soft palate should be cut through at their attachment to the bone.
4. Bring the edges of the flaps into exact apposition by silver sutures. In this operation large branches of the palatine artery are divided, and there may be pretty profuse hæmorrhage. The operation for cleft palate is rarely performed till the child is two or three years old.

OPERATIONS FOR HARE-LIP.

The fissure is more frequently on the left than on the right side. The operation is best performed between the first week and third or fourth month. Chloroform may be given without danger.

Steps of the Operation.

1. The child is wrapped in a sheet, and held by an assistant. Raise the lip, and divide close to the superior maxilla the band of mucous membrane which is reflected from the posterior surface of the lip.
2. Grasp the left limb of the cleft with a pair of forceps or with the fingers, and with a knife or scissors remove completely the mucous membrane covering its free surface, taking care to continue the incision a little above the cleft, to make sure of removing the mucous lining of the angle of the cleft. See Fig. 51.
3. This portion of the lip being transferred to an assistant, grasp the other portion of the lip and remove its mucous covering in a similar manner. The coronary arteries will

bleed freely. They lie between the mucous membrane and the orbicularis oris.

4. Introduce a hare-lip pin into one flap about half an inch from its cut margin, and pass it deeply into the lip substance, so that it emerges beneath the orbicularis, between it and the mucous membrane. Then pass the point into the opposite lip, entering it between the mucous membrane and muscle, and causing it to emerge at a point about half an inch from the cut margin. A figure of eight of silk wound round the ends of the pin brings the edges of the incisions together, and compresses the blood-vessels. More pins may be introduced if necessary. Then bring the edges of the incisions at their upper and lower extremities into accurate contact by means of wire sutures.

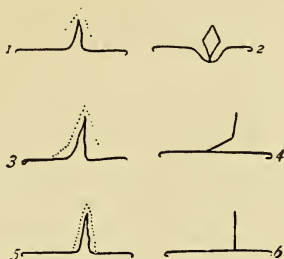


Fig. 51.

These diagrams are intended to represent three different operations for hare-lip.

In 1 the lip and cleft are indicated as a continuous dark line, and the incisions half way down each cleft are represented as dotted lines.

2 shows the method of the approximation of the flaps formed in 1.

In 3 the angular dotted line to the left of the cleft shows the line of the incision by which this margin of the cleft is removed. The dotted line to the right of the cleft shows the line of the incision by which this margin of the cleft is converted into an angular flap, and in 4 the manner in which this flap is fixed is shown.

In 5 the dotted lines indicate the incisions usually made in simple cases of hare-lip.

In 6 the incised margins are brought together.

5. Cut narrow strips of plaster, and fix them between the pins, so that they may assist in preventing strain. Remove

the points of the pins, guarding their extremities with plaster.

6. Remove the lowest pin on the fourth day, and the others on the next, leaving the plaster in position for a few more days.

When the intermaxillary bones project to any extent, and are separated from the remainder of the upper jaw, it is usually wiser to remove them with the knife or scissors. As Mr. Bryant points out, when they are bent back, the central incisor teeth too often grow in some abnormal position, and are in the way, while, when they are removed, the maxillary bones subsequently approximate.

Two other methods of cutting the flaps and closing the clefts are delineated in Fig. 51, as No. 1, 2, 3, 4.

SECTION XIII.—OPERATIONS ON RESPIRATORY APPARATUS.

LARYNGOTOMY.

In laryngotomy the crico-thyroid membrane is divided and a tube inserted.

Mode of Operation.

1. Make a vertical median incision from the centre of the thyroid cartilage downwards for an inch or an inch and a half, dividing skin and superficial fascia, and exposing deep fascia.
2. Cut through deep fascia, and expose the lower portion of thyroid cartilage, the crico-thyroid membrane, and the cricoid cartilage. In the areolar tissue superficial to these structures a small plexus of veins is seen, and deeper still the crico-thyroid artery lying on the crico-thyroid membrane. These may be pushed aside or twisted if in the way. A portion of either of the crico-thyroid muscles may be seen covered by fascia.
3. The membrane may be opened by a transverse incision of sufficient size to allow of the insertion of the tube.

Some surgeons prefer a vertical incision. In some cases it may be necessary to make a crucial incision.

It is better to use a tube which is oval transversely on section than a tube which is quite circular, so as to correspond with the shape of the space. The objections urged against this operation are :—1. That the tube, by being retained in the crico-thyroid space, is apt to produce serious inflammation, and even necrosis of the cartilage. 2. That the crico-thyroid space does not admit a sufficiently large tube. 3. That the integrity of the larynx is impaired. 4. That the tube in this situation gives rise to more irritation than it does in the trachea.

TRACHEOTOMY.

The trachea may be opened above or below the isthmus of the thyroid gland, the former operation being called superior tracheotomy, and the latter inferior tracheotomy. The isthmus lies on the second, third, and fourth rings of the trachea.

INFERIOR TRACHEOTOMY.

Inferior tracheotomy is an operation which may, in some cases, be performed with the greatest ease, as when practised in an adult, previous to removing the tongue by Kocher's method; or it may be accompanied by such dangers that it requires as much skill and presence of mind as any operation in surgery. This is in the case of young children suffering from urgent dyspnoea, with short fat necks, and large veins crossing the median line. Consequently, it is an operation which is much modified by circumstances.

Steps of the Operation.

1. Whether the patient is put under chloroform depends

much on the condition necessitating tracheotomy, and the urgency of the symptoms. Place the patient with the head near the edge of the table, and a hard pillow, or, better still, a sand-bag, beneath the neck. By this means the front of the neck is made more prominent, while the rapid riding up and down movement of the trachea is very much diminished.

2. Standing on the right side of the patient, define carefully the exact position of the thyroid and cricoid cartilages, and the upper border of the sternum. Then make a median incision from just below the cricoid cartilage to a point, near to, if not quite corresponding to the upper margin of the sternum. In an adult, the incision may be much shorter, but in very young subjects, in the presence of urgent symptoms, the longer incision is preferable, as it renders the subsequent stages of the operation less difficult. It also diminishes the risk of subcutaneous emphysema. In this incision you divide skin and superficial fascia, and in the latter you may cut the anterior jugular vein, or a communication between the two anterior jugulars, across the middle line. These may be ligatured if necessary. The deep cervical fascia is exposed in the wound.
3. Now divide this fascia carefully. It consists of two layers, separated by an interval, which is greater below than above. Beneath this are thinner layers of fascia connecting the sterno-hyoid and sterno-thyroid muscles. A quantity of fat is exposed, and you may see, above the lower margin of the isthmus of the thyroid, and below in young subjects, the thymus gland. In some cases the left innominate vein may be seen bulging into the wound below. Running vertically down from the isthmus, are seen the inferior thyroid veins. In some cases it is possible to separate these in the

middle line, and expose the layer of deep cervical fascia covering the trachea. In other cases it is necessary to divide them. If possible, they should be ligatured, or clamped, previous to doing so.

4. Now expose the deep fascia covering the anterior surface of the trachea, and in doing this you may divide small branches of arteries. Occasionally a large artery, the thyroidea ima, usually a branch of the innominate, runs up on the anterior surface of the trachea, where it may be divided.

Now divide the fascia covering the trachea, and fixing the trachea by the forefinger pressed on it above, or by the short sharp-pointed hook, should there be much riding of the trachea up and down, insert the knife, with its edge upwards, and cut through three or four rings, taking care not to cut through the posterior wall of the trachea and enter the œsophagus. The number of rings divided depends on the condition requiring the operation, as, in the case of a foreign body in the trachea, it is necessary to divide more rings than in the case of an operation in the adult, for the purpose of inserting a Trendelenburg's canula.

5. Now introduce a tube, or Golding Bird's dilator, and fasten it firmly round the neck with tapes.

If the operation is done in great haste, as it so frequently is, the course you would pursue is to place the child in the same position, rapidly define the position of the cricoid cartilage, and with the finger and thumb grasp the trachea, so pushing back the large vessels on either side, and making the skin over it tense. Now cut quickly through the structures already mentioned, by one, two, or three incisions, till you expose the anterior surface of the trachea. This you open at once, and insert the tube.

Should there be severe hæmorrhage from divided veins, do not attempt to control it, but open the trachea, insert the blades of Trousseau's dilating forceps, or even of an ordinary pair of dressing-forceps, turn the child on its face, and separate the blades. By this means air will enter freely, blood will run away from and not into the wound, and in a few seconds all bleeding will cease, any membrane which may be present can be removed, and the tube inserted as before.

It may be necessary sometimes to perform artificial respiration, should much blood have got into the trachea.

SUPERIOR TRACHEOTOMY.

Superior tracheotomy, as modified by Professor Bose,¹ is now very frequently performed in preference to inferior tracheotomy. It is a much less formidable operation, as the trachea is here so much more superficial, and there is no risk from hæmorrhage.

Steps of the Operation.

1. Place the patient in the same position as in inferior tracheotomy. Define carefully the position of the cricoid and thyroid cartilages.
2. Make a longitudinal median incision extending from the centre of the thyroid cartilage to just below the isthmus of the thyroid, dividing skin and superficial fascia. In the fascia you may divide the anterior jugular or a communicating branch between the anterior jugular vein on either side. The deep cervical fascia is exposed at the bottom of the wound.

¹ Morrell Mackenzie, "Diseases of Throat and Nose."

3. The assistant now draws the edges of the wound apart by retractors, or better still a spring dilator may be used.
4. Pick up the deep fascia with dissecting forceps, and make a transverse incision half an inch long through it at the level of the upper margin of the cricoid cartilage in the middle line. This is shown in Fig. 52. In doing this

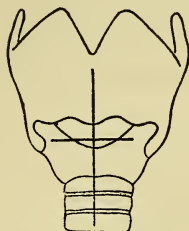


Fig. 52 represents the thyroid and cricoid cartilages, and the upper three rings of the trachea.

The vertical skin incision is seen as it extends from the centre of the thyroid cartilage to the second or third ring of the trachea.

The horizontal dark line indicates the transverse incision through the deep cervical fascia.

- you do not divide the crico-thyroid artery as it lies on the crico-thyroid membrane. This membrane is now exposed in part with the anterior surface of the cricoid cartilage, and a little portion of each crico-thyroid muscle covered by fascia.
5. Now introduce the end of a director between the deep fascia and the cricoid cartilage and trachea, and then raise the director to a right angle with the trachea, so turning the fascia with the veins in it and the thyroid isthmus down from the anterior surface of the trachea corresponding to the upper three or four rings.
 6. Now divide the trachea in the usual way.

PLEURISY OR EMPYÆMA.

1. The area of the fluid or pus-containing cavity is carefully defined. The patient (if a child) should be put under chloroform, and a fine aspirating needle introduced under the spray through one of the lowest intercostal spaces

bounding the cavity. The fluid is then slowly withdrawn, the greatest care being taken not to puncture the lung, and so allow air to escape into the cavity. The aspirating needle is held obliquely, so that its point rests on the inner aspect of the chest-wall. When the greater part, if not almost all the fluid contents have been removed, the needle is withdrawn.

2. Subsequently it may be necessary to remove in a similar manner fluid or pus from a smaller residual cavity, as, after the withdrawal of the bulk of the fluid, the cavity usually diminishes very considerably in extent.

INTERCOSTAL INCISION.

1. If an empyæma be of some standing, aspiration alone may frequently fail to do more than lessen considerably the area of the pus-containing cavity. This is due to the thickness of the layer of organized lymph lining the cavity, and to the amount of solid material contained with the pus in the cavity. In such cases you carefully define the area of the pus-containing cavity by the usual physical signs, and particularly by the *free use of a very fine aspirating needle*. Then make an incision about two inches long through one of the lowest spaces, and open the cavity. Having removed the fluid contents, introduce a drainage tube. The incision is usually made along the upper border of the lower rib, in order to avoid the artery which lies beneath the lower margin of the upper.

COSTAL RESECTION.

In old standing cases of empyæma in children, where you suspect the presence of much caseous lymph, and where the

pleural walls are thick, or in small localized empyæmas, especially when situated in the back part of the chest, the shortest and most certain mode of treatment is to remove a portion of a rib from the chest wall where it bounds the lowest part of the cavity. By these means you drain the cavity most completely. I have described this operation in detail in the Guy's Hospital Reports for 1882,¹ and have related cases showing the advantages of this form of treatment, and in some of these I had every opportunity of verifying its advantages on the dead subject.

Steps of the Operation.

1. Carefully define the pus-containing area, noting the lowest point of the cavity, and marking the rib which lies just above its lower limit.
2. Make an incision three inches long through the skin, superficial fascia, and muscles down to the rib, exposing the periosteum.
3. Divide the periosteum on the rib longitudinally for about an inch, and then, by means of a raspatory, turn it off the outer aspect of the rib for that length.
4. Then separate the periosteum from the inner aspect of this piece of rib with the handle of the scalpel, and using a pair of bone forceps with long narrow blades, remove about three-quarters of an inch of the portion of rib exposed.
5. Puncture the pleura and periosteum now exposed with a director, and introduce through the opening so made the blades of a pair of dressing forceps. Separate the blades, and withdraw the forceps. By this means you dilate the opening in the pleura as much as you like without any

¹ "Empyæma in Children Treated by Removal of a portion of Rib."

risk of hæmorrhage, and should you by chance divide one of the intercostal arteries, you can easily ligature it.

6. The fluid escapes freely through this opening, and you can remove with the greatest facility the caseous lymph which is found frequently in masses of some considerable size in the lower part of the cavity. You can examine the cavity by the finger introduced through the opening, and you can detect the presence of any neighbouring localized collection of pus, and break down any intervening adhesions, that could in any way interfere with the free escape of the fluid contents of the cavity.
7. Having thoroughly emptied the cavity, introduce a short rubber tube as thick as your finger between the ends of the ribs, *taking care that its inner opening is flush with the inner aspect of the costal wall.* Fix the tube by wire sutures passed through the skin, intercostal muscles, and tube. Apply gauze dressings and elastic bandages to prevent the entrance of air beneath the bandages.

In this operation you clear the cavity of all its contents, you obviate the possibility of any collection of pus in the intervals between the dressings by this method of thorough drainage, there is no drainage tube in the abscess cavity keeping up irritation, and allowing a certain amount of pus to collect below the level of its inner opening, and the cavity closes up very rapidly indeed.

There is no risk of caries or necrosis of the rib, and some months after the wound has healed it is often impossible to feel any irregularity of the rib outline at the point of resection.

In empyæmas, which have been opened, and have become chronic, you remove a portion of the bony framework of the chest with two objects, firstly to establish more perfect drainage, and secondly to allow the outer wall of the abscess cavity, deprived of its rigidity by the removal of the ribs, to

become approximated to the opposite wall of the cavity, which is formed by thick pleura covering indurated lung. It is to be hoped that with improved primary treatment of the empyæma, cases requiring extensive costal resection will not occur so frequently as they do at present. I believe that primary resection of the rib entails no more risk than does the ordinary intercostal incision, while it is incomparably superior to it in its results. In removing any considerable portion of the bony framework of the chest, the steps of the operation are practically the same as those pursued in the primary resection just described. In removing the thickened pleura, there is no danger from hæmorrhage, as any bleeding vessel can be readily controlled.

SECTION XIV.—OPERATIONS ON THE INTESTINAL TRACT.

ŒSOPHAGOSTOMY.

Steps of the Operation.

1. The position of the hyoid bone, sternal notch, and stricture having been carefully defined, an incision is made along the anterior margin of the left sterno-mastoid from the sternal notch to the level of the hyoid bone, exposing the anterior margin of this muscle. In doing this you divide skin, superficial fascia containing some platysma above, branches of the superficial cervical nerve, and occasionally the anterior jugular vein or a communication between it and the external jugular.
2. Hook outwards the sterno-mastoid, exposing deep fascia beneath it, and branches of the superior thyroid artery entering its under surface. In the deep fascia is seen the omo-hyoid muscle above, and below, separated from the omo-hyoid by an interval, the sterno-thyroid, and, superficial to the sterno-thyroid, the sterno-hyoid.

If it is necessary to open the œsophagus pretty low down, as is usually the case, divide in the direction of the first incision the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles with the fascia enclosing them, and branches

of the communicans and descendens noni to these muscles. The anterior jugular vein is usually divided as it crosses the two sternal muscles superficially at the lowest part of the incision, but it should be avoided if possible. Expose the middle thyroid veins which pass outward superficial to the sheath of the carotid vessel. Divide these between ligatures, if they cannot be hooked aside.

3. Now hook the carotid sheath outwards, and the trachea and thyroid gland inwards, and expose the œsophagus as it lies to the left of the middle line at this level of the neck. Keep clear of the recurrent laryngeal nerve where it lies in the angular interval between the trachea and œsophagus, and higher up avoid the inferior thyroid artery as it passes to the posterior portion of the left lobe of the thyroid body, surrounded by branches of the middle cervical ganglion.
4. Grasp the œsophagus with forceps and pass a ligature through its side from before backwards. Then make a small longitudinal slit through its walls and expose the suture, which you hook up and divide in its centre. By drawing forward each lip of the œsophageal wound by the ligature which holds it, you can connect it to the margins of the skin incision by interrupted sutures.

In some cases it may be possible to connect the œsophagus, and to allow the wound to heal partly before opening its cavity. A tube or sound has been passed into the œsophagus from the mouth, when much difficulty has been experienced in finding the œsophagus to serve as an indication of its position.

ŒSOPHAGOTOMY.

This operation is performed to remove a foreign body, in which case it is generally necessary to open the œsophagus

higher up than under circumstances requiring a permanent opening. In these cases the seat of obstruction is the upper extremity of the œsophagus, or the lower extremity of the pharynx. The operation differs but slightly from œsophagostomy.

The position of the foreign body can be defined from the outside, or by the passage of a probang.

GASTROSTOMY.

It is divided into two stages : 1. To open the abdomen, and secure the stomach to the opening ; 2. After a lapse of some days to open the stomach.

Steps of the Operation.

1. Carefully define the lower margin of the liver. Make an incision three inches long through the skin and superficial fascia, parallel to the margin of the chest-wall, and about an inch distant from it, the centre of the incision corresponding to a point three-quarters of an inch internal to the outer edge of the rectus muscle. In the superficial fascia are divided filaments of the anterior cutaneous branches of the lower intercostal nerves and anterior divisions of their lateral cutaneous branches, accompanied by branches of corresponding arteries.
2. Cut through deep fascia, which is thin and membranous, and expose, in the anterior part of the wound, the anterior layer of the sheath of the rectus, marked by a depression formed by a tendinous intersection, and in the posterior part of the wound the aponeurosis and a portion of the fleshy portion of the external oblique. Further branches of the arteries and nerves mentioned above are divided.

3. Make a vertical incision, an inch and a half long, in the sheath of the rectus, three-quarters of an inch inside its outer margin, and then—
4. Open the rectus longitudinally for about an inch, separating the fibres as much as possible, rather than cutting them. You divide the anterior branches of the lower intercostal nerves and arteries, and in the posterior aspect of the muscle branches of the superior epigastric artery. (The advantage of dividing the rectus in this manner is that it forms a sphincter to the opening in the stomach, and prevents the escape of its fluid contents.) The posterior layer of the sheath of the rectus is now exposed.
5. Divide this carefully, and expose the transversalis fascia beneath it.
6. Divide this also, exposing subperitoneal fat, and on dividing this, you see peritoneum. Having stopped all bleeding—
7. Pick the peritoneum up with a pair of forceps, and divide it in the axis of, and for the length of, the incision in the rectus.

In most cases the stomach will bulge into the wound, but the transverse colon may present itself instead. The colon may be recognized by its relatively thin walls, the presence of longitudinal bands, and of appendices epiploicæ. Should it appear, it is to be gently displaced downwards. The liver may project and completely close the opening, in which case it would be necessary to prolong the incision downwards. If the omentum appears, it can be pulled on gently till the stomach comes into view, when it will bulge out of the wound.

8. Pass carbolized silk sutures, at intervals, through the serous and muscular coats of the stomach, in a circle whose centre corresponds to the wound, and whose radius is about three-quarters of an inch long. After each suture is

passed through the stomach-wall, pass it through the abdominal-wall, fastening the ends over a piece of quill. Then unite, by an inner circle of carbolized silk sutures, the serous coat of the stomach to the edges of the incision.

9. After an interval of from three to five days, puncture the portion of the stomach within the inner circle of sutures with a sharp-pointed bistoury. In some cases considerable difficulty may be experienced in puncturing the mucous membrane, owing to its loose attachment to the muscular coat. The sutures should not be removed for ten days. The great improvements that have been made in this operation are the work of Mr. Howse. He has also, for some time, done away with the use of sutures in connecting the stomach-wall to the opening in the abdominal-wall. He grasps the outer coats of the stomach with a pair of loose torsion forceps, the blades of which are shielded with rubber, and lays the forceps on the surface of the abdomen beneath the antiseptic dressing. By this means, the stomach is retained in position till adhesions have formed between the opposing peritoneal surfaces.

EXCISION OF THE PYLORUS.

BILLROTH'S OPERATION.

Steps of the Operation.

1. The patient has been carefully fed during the period antecedent to the operation, and the stomach washed out with tepid water daily for some days before the operation, and then again very thoroughly two hours before. The bowels should have been freely opened, the extremities wrapped in flannel or cotton wool, and the temperature of the room carefully regulated.

2. The patient being under chloroform, define the tumour. Should it have dropped very low down in the abdomen, replace it as far as you can in its original position.

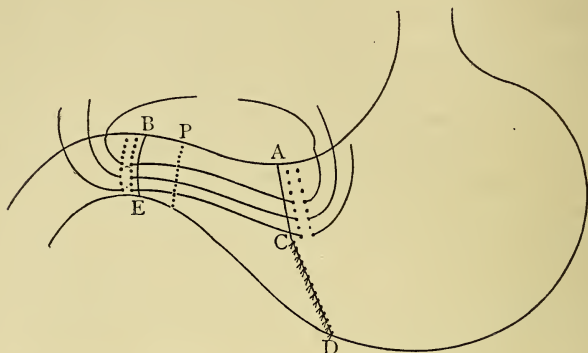


Fig. 53 is a diagram showing the lines of incision for removal of the pylorus.

B E is the line of section of the first part of the duodenum

C D „ line of section through the lower two thirds of the stomach.

A C „ „ „ upper third „ „

P „ position of the pylorus.

The sutures connecting the anterior surfaces of the stomach and duodenum are shown as they enter, pass through, and emerge from the peritoneal and muscular coats of the stomach, and then as they enter, pass through, and emerge from the same coats of the duodenum.

Between C and D are a line of sutures similar to those just above, by means of which the peritoneal aspects of the lower two thirds of the stomach have been brought together.

3. Make a transverse incision about four or five inches long over the seat of the tumour, dividing the various structures in the abdominal wall, ligaturing all vessels, and exposing the peritoneum in the bottom of the wound. Divide the

peritoneum, exposing the tumour. Define its extent and any adhesions that may connect it to adjacent structures.

4. Having ligatured and divided any slight adhesions that may be present, draw the stomach out of the wound, and examine it to determine the directions along which you intend to carry your incisions.
7. Keep the portion of the stomach which you will subsequently return into the abdomen carefully covered by a warm moist cloth.

By means of two pairs of directing forceps, carefully tear through the great omentum at its attachment to the greater curvature of the stomach, separating in it the right gastro-epiploic artery and vein, and removing from it any enlarged glands that may be present. See Fig. 53.

It may be necessary to tear through the ascending layer of the transverse meso-colon, separating the superior pancreatico-duodenal artery in it from the first portion of the duodenum. See Fig. 54.

8. Tear through in a similar manner the attachment of the lesser omentum to the lesser curvature and duodenum within the limits of intended removal, separating in the omentum the pyloric artery, and removing any lymphatic glands that are found to be enlarged.
9. If much of the first part of the duodenum has to be removed, you must now separate from it the hepatic artery that lies above it, and the pancreatico-duodenal artery, portal vein, and common bile-duct which lie behind it, dividing the reflection of the peritoneum of the lesser bag on to its posterior surface.
10. Having now separated the portions of stomach and duodenum to be removed from their attachments, place a large clean sponge beneath them.

Grasp the cancerous pylorus, and cut with scissors

obliquely through the stomach, commencing at the greater curvature. Divide both anterior and posterior walls, till you reach the junction of the upper third with the lower two thirds (c d in diagram), carefully remove any of the

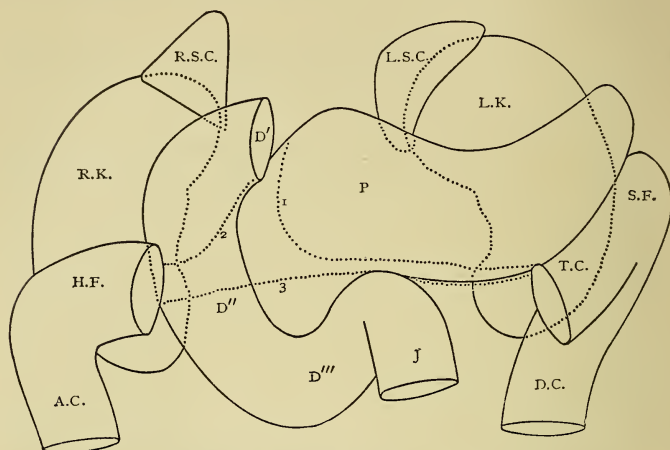


Fig. 54 shows the relations of the kidneys, supra-renal capsules, pancreas, duodenum, and colon to one another, and their relation to the peritoneum.

This drawing is introduced here to show the line of reflection of the peritoneum of the lesser bag as indicated by the dotted line 1, and of that portion of the ascending layer of the transverse meso-colon formed by the great bag, and indicated by the dotted line 2.

The ascending layer of the transverse meso-colon formed by the lesser bag of the peritoneum is indicated by the horizontal portion of the dotted line 1. 3 represents the descending layer of the transverse meso-colon.

fluid contents of the stomach, if present, and ligature any bleeding vessel.

Bring accurately together with carbolized silk sutures the peritoneal aspects of the cut margin of the stomach, using that mode of suture shown in Fig. 53.

11. Divide the remaining third of the circumference of the stomach (A C in diagram).

Divide the duodenum from above downwards (B E in diagram), and introduce a sponge into it to prevent the escape of any of its contents.

12. Bring the divided margins of stomach and duodenum into apposition, and connect the posterior walls of each by

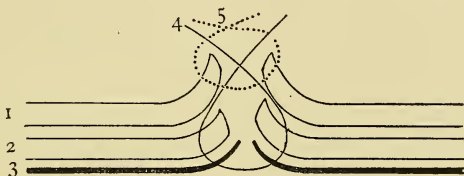


Fig. 55 is a diagram showing the coats of the stomach and duodenum, and the sutures by which their divided posterior walls are brought together.

1 indicates the mucous membrane.

2 „ „ muscular coat.

3 „ „ peritoneal coat.

4 „ „ suture which is passed between the mucous and muscular coats, and then through the muscular and peritoneal coats of the stomach. It is then passed through the peritoneal and muscular coats, and after that between the muscular and mucous coats of the cut margin of the duodenum.

5 indicates the suture connecting the divided margins of the mucous membrane.

carbolized silk sutures. These, as shown in Fig. 55, are to be passed between the mucous membrane and muscular coats of the stomach, through the muscular and peritoneal coats, then through the peritoneal and muscular coats of the duodenum, and between its mucous and muscular walls. Should the edges of the mucous membrane not come into accurate apposition, they should be connected

by small sutures. These are shown in Fig. 55 as the dotted line 5.

13. Remove the sponge from the duodenum, and connect the peritoneal aspects of the anterior walls of the stomach and duodenum by sutures, as seen in Fig. 53. These sutures should pass through the peritoneal and muscular walls only. Replace these parts in the abdomen.

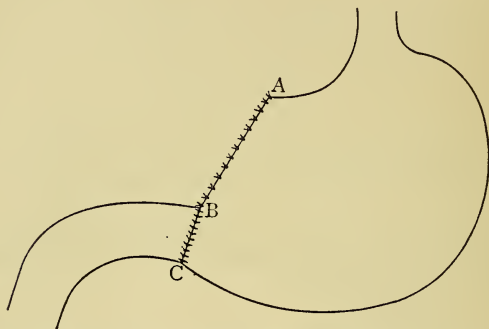


Fig. 56 shows a dilated stomach in which the pylorus has been removed, and the duodenum has been stitched to the convexity of the stomach instead of to its concavity as in Fig. 53.

In this case the walls of the upper two thirds of the stomach have been united to one another by the same suture as used in Fig. 53.

B C shows the appearance presented by the line of union of the duodenum and stomach when the sutures have been tied.

Should the stomach be much dilated, you must divide it from above downwards, and connect the duodenum to the lower third of the section (B C, Fig. 56), and not to the upper third, as previously described. By this means, you obviate the formation of a diverticulum below the duodenal orifice.

14. The edges of the incision through the abdominal wall are

now brought together, the sutures being so passed that the peritoneal margins are in accurate apposition.

Should you find that the growth is too much adherent to neighbouring structures to permit of its removal, you should perform jejunostomy.

JEJUNOSTOMY.

In *Jejunostomy* you take up with forceps the jejunum about two inches from the duodenum, and place it in the most convenient point in the abdominal incision, the edges of which you now bring together by sutures. Then stitch the jejunum to the opening left by numerous interrupted sutures. The bowel is opened on the third or fourth day after the operation.

Mr. Golding-Bird has performed the first operation of jejunostomy in England, and the short abstract of his description of the case is contained in the "British Medical Journal," December 5, 1885. It is very probable that this palliative operation will be performed more frequently in cases in which the radical operation of pylorotomy cannot be entertained. It is also less difficult and less tedious than the latter operation.

LUMBAR COLOTOMY.

The operation of colotomy is usually performed in the left lumbar region, but the same description applies to the steps of the operation on either side. The descending colon rests posteriorly on the anterior surface of the quadratus lumborum, at its inferior external angle; from this it is separated by transversalis fascia, and the anterior layer of the transversalis aponeurosis. Above this it rests on the undivided transversalis

aponeurosis and the transversalis fascia. It then gets on to the anterior surface of the lower end of the kidney. The gut is usually opened between the points where it lies on the kidney and on the quadratus lumborum. It is covered on its anterior and lateral aspects by peritoneum.

Steps of the Operation.

1. Place the patient on the right side, supporting the abdomen with a pillow, if necessary. You may then mark on the skin a line which will extend vertically upwards from a point midway between the anterior and posterior superior spines of the ilium to the margin of the thorax. This line is said, by some authors, to touch the point of the twelfth rib; but the rib touched differs according to the length of the lower two ribs, and this varies enormously in different cases. I have referred to these variations elsewhere.¹
2. Now make an incision, three inches long, whose direction is forwards and downwards, and whose centre corresponds to a point in the vertical line midway between the crest of the ilium and the margin of the chest. You divide skin and superficial fascia. In this fascia are divided cutaneous filaments of the posterior division of the last dorsal and first lumbar nerves, with accompanying arterial branches, and branches of the posterior divisions of the lateral cutaneous branches of the tenth and eleventh intercostal nerves and arteries.
3. Cut through the deep fascia, which is now exposed, and you see the latissimus dorsi in the posterior part of the incision, and the external abdominal oblique in the anterior.
4. Divide the latissimus dorsi where exposed, and you see a

¹ Guy's Hospital Reports, vol. xxvii., "Cervical and Bicipital Ribs in Man."

further portion of the external oblique beneath it. Behind its free margin you see the lumbar aponeurosis, and, if well developed, a portion of the serratus posticus inferior.

5. Cut through the external abdominal oblique within the limits of the incision, and expose the internal abdominal oblique, the direction of whose fibres is upwards and forwards. Behind it a further portion of lumbar aponeurosis is exposed.
6. Divide the internal oblique and expose the transversalis muscle and undivided aponeurosis, which you now see to be continuous with the lumbar aponeurosis.

In a large number of cases the undivided transversalis aponeurosis is now seen to give off the lumbar aponeurosis at this point, but if the last rib is longer than usual, the quadratus is consequently broader, and at this level it has not yet passed under cover of the erector spinæ. If so, you will then see the transversalis aponeurosis giving off the layer of aponeurosis which passes behind the quadratus lumborum, and that again giving off the lumbar aponeurosis.

Anatomists do not appear to notice this fact sufficiently. The last dorsal nerve and artery are seen to perforate the undivided aponeurosis.

7. Divide the undivided transversalis aponeurosis, and in those cases in which the quadratus is broad, also the layer of the aponeurosis which covers its posterior surface; you expose transversalis fascia, and the quadratus lumborum should it project here beyond the erector spinæ.
8. Divide the transversalis aponeurosis and expose subperitoneal fat and the outer aspect of the colon usually uncovered by peritoneum in the interval between the outer border of the quadratus and the kidney. This last viscus will be seen or felt in the wound. See Fig. 54.

In some cases much difficulty is experienced in getting hold of the colon, and some surgeons have distended the rectum with air or fluid to facilitate matters.

9. The gut having been brought to the surface can now be opened by transfixing it by two or more sutures, opening the gut, dividing the ligatures in it, and tying them to the margins of the skin wound. For some time at Guy's Hospital the gut has been treated in much the same way as the stomach is in gastrostomy, namely, the operation is performed antiseptically, and the gut fastened in the wound by small clamps. These are retained in position long enough to allow of adhesions forming and of a partial healing of the wound. An opening is then made into it.

LUMBAR COLECTOMY.

In this operation the stricture or growth is removed through the incision in the loin made for colotomy. The edges of the divided gut may be sutured to the margins of the skin incision or to one another. Mr. Bryant first performed this operation successfully.

STRANGULATED INGUINAL HERNIA.

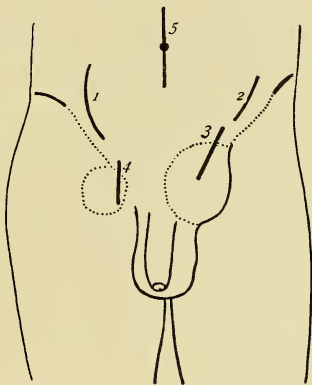
HERNIOTOMY.

Steps of the Operation.

1. The hernial and adjacent skin having been shaved, make an incision about three inches long downwards and inwards over the anterior surface of the tumour at its neck, and extending about an inch beyond the neck on the abdominal wall. See Fig. 57.

You divide skin, superficial fascia consisting of two layers, the superficial layer being thick and containing a variable amount of fat, the deeper being thin and membranous and containing no fat. Between these layers, you divide the superficial external pudic artery and vein, and branches of the iliac branch of the ilio-hypogastric and the ilio-inguinal nerves. These two layers are blended in the lower part of the incision to form the dartos.

2. Divide the intercolumnar fascia where it covers the hernia in front, and expose and examine the external ring. Should the constriction be situated at this point, it should be divided; otherwise the margins of the ring should not be cut.



3. Cut through the cremaster muscle, with filaments of the cremasteric branch of the deep epigastric artery and of the genital branch of the genito-crural nerve, and the subjacent intercolumnar fascia. Then divide the subperitoneal fat and expose the sac of the hernia.

Fig. 57 shows the lines of incisions for femoral and inguinal herniæ.

4. Now introduce your finger between the sac and the ring into the canal, and feel if there is any structure compressing the neck of the sac. If so, pass a grooved hernia director beneath it and divide it, cutting directly upwards. Having done this, carefully compress the sac, and if possible reduce its contents. Should they not pass back, after having ap-

parently divided all constricting bands, open the sac. You do this by pinching it up between your finger and thumb, making sure that you include none of the contents, and make an opening in it large enough to allow the passage of a director. Then pass the director beneath the sac, and make an incision sufficiently long to enable you to introduce your finger. Some serum may escape on opening the sac, but this is not always the case. Should the stricture have been very tight and the gut be gangrenous or partly so, this fluid may be very offensive.

5. Pass your finger along the anterior surface of the gut towards the neck of the sac, and having carefully defined its margin, introduce a hernia knife along your finger or along a director resting on it, and divide the constricting neck of the sac in an upward direction. Make the incision long enough to allow of the tip of your finger being passed into the abdominal cavity. Now reduce the gut. Should there be a large amount of omentum in the hernia, it may be ligatured with carbolized silk, divided below the ligature, and the stump returned into the abdominal cavity. The sac, if small, may be dissected from the cord and removed, its upper extremity being firmly enclosed in a silk ligature, but if the sac is very large, it is advisable to separate the neck from the cord, and surround it with a tight ligature.

Some surgeons attempt to bring together the pillars of the external ring with wire or gut sutures.

STRANGULATED FEMORAL HERNIA.

HERNIOTOMY.

Steps of the Operation.

1. Define the position of the spine of the pubes. If the hernia

is above this point it is inguinal; if below, crural. Define also Poupart's ligament.

2. Make an incision, two or three inches long, over the pubic side of the neck of the tumour, so that it extends an inch above Poupart's ligament. This you may do by cutting down on the tumour, or by pinching up the skin, transfixing it, and cutting forwards. See Fig. 57.

You cut through skin and superficial fascia, the latter consisting of two layers. The superficial layer alone is divided above the level of Poupart's ligament. It contains a variable amount of fat. The deep layer is thin and membranous, and attached to Poupart's ligament. Between or beneath the layers are divided the superficial, and occasionally the deep external pudic arteries and veins, lymphatics from the penis when they pass to the superficial femoral glands, and branches of the ilio-hypogastric, ilio-inguinal, and crural branch of the genito-crural nerves.

3. Carefully define Gimbernat's ligament and that portion of the iliac fascia which is attached to its anterior margin.
4. Divide the cribriform fascia, crural sheath, and the sub-peritoneal fat where it covers the exposed aspect of the hernia.

Introduce a hernia director, with great care, between the free margin of Gimbernat's ligament and the hernial sac, which is now exposed, and passing a hernia knife along the groove, make a short incision in a direction upwards, or upwards and inwards. In doing this you cut the margin of Gimbernat's ligament, the deep crural arch, and that portion of the fascia lata which is attached to Gimbernat's ligament. Care should be taken not to make this incision too extensive, or the cord itself may be injured.

The contents of the sac should now be returned by exerting steady pressure upon it.

5. Should you not be able to return the gut, pick up a portion of the sac with dissecting forceps, and make a small opening in it. Introduce a director, and increase the size of the opening. Pass the hernia director between the gut and the neck of the sac, and divide it in a similar direction.

You may now separate the sac from the adjacent structures, and tie a ligature around its neck, afterwards removing the greater portion of the sac.

The septum crurale and the crural sheath constitute a single very thin covering of the hernia which is known as the fascia propria of the hernia (Astley Cooper). It not unfrequently happens that an aberrant obturator artery descends into the pelvis at the outer side of the ring, or immediately behind it; and, in some rare cases, that vessel passes over the ring to its inner side. An obturator vein has occasionally the same course.

STRANGULATED UMBILICAL HERNIA.

HERNIOTOMY.

Steps of the Operation.

1. Make an incision in the median line, commencing about two inches above the neck of the sac, and extending on to the sac as far as may be thought necessary. Great care should be taken not to cut through both the thin skin and closely adherent sac of the hernia in the same incision.
2. Clear the neck of the hernia above, and divide the fibrous tissues bounding the orifice above in an upward direction.
3. If you cannot then return the contents of the sac, make a

small incision into its upper part, and carefully divide its neck in the same direction as the last.

Mr. Clement Lucas recently read a paper before the Clinical Society, in which he urged the great advantages of removing the whole sac, and bringing the edges of the ring into apposition by sutures, care being taken to oppose the peritoneal margins.

A difficulty in retaining the viscera in the abdomen, and consequently in bringing together the edges of the ring, is occasionally experienced. The feeling of the meeting was strongly in favour of the operation proposed by Mr. Clement Lucas.

RADICAL CURE OF HERNIA.

The operations for the radical cure of femoral, inguinal, and umbilical herniæ, have practically been given in the descriptions of the several operations for the relief of strangulation. There are many modifications of each operation, but the main object of each is to occlude the neck of the sac as high up and as completely as possible.

LITTRÉ'S OPERATION.

Steps of the Operation.

1. The child is placed on the back. Make an incision in the left groin about two or two and a half inches long, extending from a point midway between the umbilicus and anterior superior spine downwards and slightly inwards towards Poupart's ligament, avoiding the position of the deep epigastric artery. You cut through in order skin, superficial

fascia, with cutaneous branches of the eleventh dorsal nerve, and of the superficial external circumflex artery and vein; deep fascia, external oblique, internal oblique, and transversalis muscle; between the two last-mentioned muscles, branches of the last dorsal, ilio-hypogastric, and ilio-inguinal nerves, and of the ascending branch of the deep circumflex iliac artery; beneath the transversalis muscle, transversalis fascia, subperitoneal fat, and peritoneum.

2. Draw the sigmoid flexure forwards, and carefully attach it to the margins of the opening, so that peritoneal surfaces are everywhere in exact apposition. Open the gut, and attach the edges of the opening to the margin of the wound.

If the operation be performed for chronic obstruction, an interval may elapse between the first portion of the operation and the opening of the gut.

This operation was originally proposed for imperforate anus, but may be applied to any form of internal strangulation or obstruction dependent on mischief confined to the small intestine. In that case you open the small intestine where it is dilated above the obstruction.

OPERATION FOR INTERNAL STRANGULATION BY BAND, ETC.

Steps of the Operation.

1. Make a median incision between the umbilicus and symphysis long enough to admit the hand, dividing skin, superficial and deep fasciæ, the conjoined aponeurosis of the oblique muscles, the transversalis, the pyramidalis if the incision extends far enough downwards, transversalis fascia, subperitoneal fat, and, after ligaturing every bleeding point, cutting through the peritoneum.

2. While you prevent the escape of the intestines, introduce your right hand into the abdominal cavity and examine the condition of the cæcum. Should it be distended, you know that the obstruction is situated in the great gut, where you can easily find it. Should the cæcum be empty, you must look for the seat of strangulation in the small intestine. This you do by feeling in the pelvis for the gut, which is contracted and empty beyond the seat of obstruction. Having found it, withdraw it from the abdominal cavity, and examine its mesentery to determine its direction. Trace the contracted gut upwards till you reach the stricture.
2. Liberate the strangulated gut by dividing the constricting band, diverticulum or vermiform appendix, in the last two instances bringing the peritoneal coats of the divided gut into exact apposition by the suture used in Fig. 59. You may be much assisted in doing this by aspirating the gut distended above the obstruction, using a very fine needle. If you think the strangulated gut will recover leave it in the abdomen, but if not there are two courses open to you; you may remove the gangrenous loop, and suture together the edges of the divided intestine, or you may remove the loop, and attach the edges of the divided gut to the wound in the abdominal wall, and by means of an operation at a later date, you may render the gut continuous. The last course is the one now almost universally approved of.
3. Having decided as to the exact extent of gut you mean to remove, you withdraw it well out of the abdomen and place clean sponges between the margins of the wound, in order to prevent contamination of the peritoneal cavity. Place clamps on the gut beyond the points of intended section, and divide the bowel, taking the greatest care that none of its contents enter the peritoneal cavity.

4. Remove the portion of mesentery connected with the gut excised, cutting it in the form of a triangle whose base corresponds to the gut. Ligature every vessel, and suture together the edges of the incisions in the mesentery.
5. Take the clamp off the distal extremity of the gut, which is probably quite empty, and connect its margin to the skin by many sutures. Then take the clamp off the proximal extremity of the gut, taking the greatest care that the contents do not escape, and attach it in a similar margin to the abdominal incision. You may now plug it with sponge.
6. Bring together the margins of the incision in the abdominal wall, accurately opposing its peritoneal lining.

Should there be much peritoneal effusion, it is advisable to wash out the peritoneal cavity with a dilute solution of corrosive sublimate, and leave in a drainage tube.

In the case of a *volvulus of the sigmoid flexure*, you may perform left lumbar colotomy, or as Mr. Treves suggests,¹ you may open the abdomen, puncture the distended gut, and attempt to reduce it. Should this fail, open the summit of the flexure, unfold the volvulus, and attach the opening in the gut to the margins of the abdominal incision. You may by a subsequent operation render the calibre of the gut continuous.

ABDOMINAL SECTION FOR ACUTE INTUSSUSCEPTION.

1. In operating on a case of *acute intussusception*, you proceed in a similar manner, and introducing the hand into the abdominal cavity, you find and expose the intussusception.
2. Grasp the mass firmly with your left hand, exerting pressure on it, while at the same time you make gentle traction

¹ "British Medical Journal," Aug. 29, 1885.

upon the entering gut. Should you succeed in reducing the intussusception, you leave it in the abdomen, if you think it will live satisfactorily. Otherwise you remove the portion of bowel involved together with its mesentery, and attach the cut ends to the abdominal incision in precisely the same manner as in the operation just described.

RESECTION OF THE INTESTINE.

As before described, you may render the ends of the excised loop continuous by suturing them together at once, using

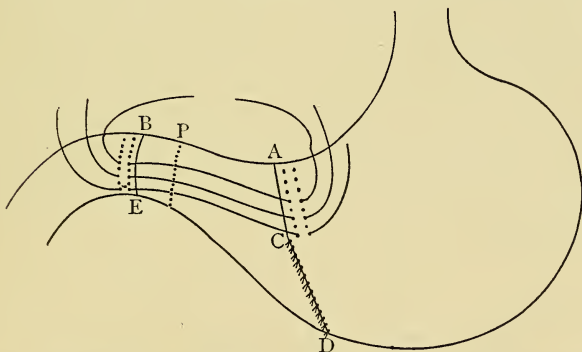


Fig. 58 shows the manner in which the sutures are passed through the two outer walls of the intestine and duodenum. The same form of suture is used to connect the divided ends of the intestine.

the suture shown in Fig. 58 alone, or by first attaching the edges of the mucous membrane, and subsequently bringing the peritoneal surfaces into apposition by means of that suture. It is usually called the Lembert suture. Or you may cut down on a fæcal fistula, having previously cleared the gut for some distance from the fistula, and plugged it with

sponge. You free the two ends of the gut from their attachment to the abdominal wall, clamp and remove a portion of each with its mesentery, and bring the edges together.

TO PARALYZE THE SPHINCTER ANI BY FORCIBLE DILATATION FOR FISSURE.

The patient being under chloroform, introduce the thumbs gradually into the anus, and separate the two thumbs in opposite directions. Make further pressure on the sphincters by applying the thumbs and exerting traction in a direction at right angles to the first. Then dilate the anus in various directions. Subsequently introduce two fingers of each hand and continue the process of dilatation, at the same time kneading the resisting tissues around the anus. Place a suppository containing half a grain of morphia in the rectum.

OPERATIONS FOR FISTULA IN ANO.

The internal opening of fistulæ is in the large majority of cases situated in the depression which exists between the external and internal sphincters. See Fig. 59, Nos. 3 to 4.

Mr. Allingham ("Diseases of the Rectum") speaks very highly of the advantages of the elastic ligature in some cases of fistula.

They are these:—(1.) There is little or no pain inflicted by the operation; (2.) The patient can walk about without danger; (3.) There is no bleeding, so that in phthisical subjects or in

deep fistulæ it is a most valuable auxiliary to the knife; (4.) The wound is often very nearly healed when the ligature cuts its way out, which it does in about six days.

TREATMENT BY THE ELASTIC LIGATURE.

Steps of the Operation.

1. Take a piece of solid india-rubber, so strong that you cannot break it. Introduce into the bowel through the fistula a probe with an open eye, or Allingham's own instrument, and attach the rubber to it. Draw it through the fistula from within outwards, and pass both ends through an oval pewter ring.
2. Pull the ends of the rubber band as tightly as you can, and with a strong pair of forceps close the ring on the bands.

The objection to the ligature is that another sinus may open into the one divided, and will probably prevent its cure. See Fig. 59, No. 8.

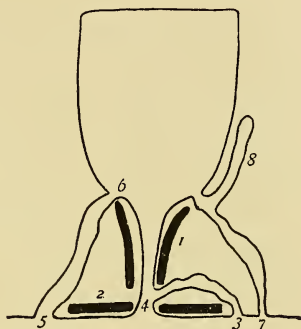


Fig. 59 is a diagram of a transverse section of the lower parts of the rectum and anus.

The dark line 1 shows the position of the internal sphincter, 2 that of the external sphincter.

The channel 3 to 4 represents the course taken by the common form of complete fistula, its internal orifice being placed between the two sphincters.

5 to 6 represents the course taken by the less common form of complete fistula, the internal orifice being placed above the internal sphincter.

8 shows a diverticulum opening below into a complete fistula, and extending upwards for some distance outside the rectum.

DIVISION OF THE FISTULA BY THE KNIFE.

Steps of the Operation.

1. The patient is placed on his side and his thighs flexed on the abdomen.
2. Pass the director into the fistula, and then insert your finger into the rectum. Feel the point of the director with the finger, and turn it out through the anus.
3. Cut along the groove in the director, dividing skin, a little mucous membrane, superficial fascia, corrugator cutis ani, and external sphincter.

If the sinus passes beneath the internal sphincter (see Fig. 59, No. 5 to 6), first dilate the sphincters, then insert the director into the fistula and the finger into the rectum. An assistant steadies the director, while you introduce a straight knife along the groove in it, and cut towards the finger. In doing this you will divide besides the structures already mentioned, mucous membrane, submucous tissue, internal sphincter, longitudinal fibres of rectum, sheath of recto-vesical fascia, levator ani, and anal fascia. When the incision is made through the posterior half of the circumference of the bowel, fibres of the recto-coccygeal muscles are cut through. Branches of the inferior and middle hæmorrhoidal vessels are cut through with branches of the inferior hæmorrhoidal and posterior superficial perineal nerves.

Having laid open the fistula, look for any secondary sinus opening into the incised channel, and if one is present, lay it open. Snip off with the scissors any overlapping edges of skin.

Introduce some carded wool into the bottom of the wound,

and place a good pad of wool over the wound between the buttocks, and apply a T bandage.

In the case of blind internal or external fistulæ, you must first make the fistula complete. In the case of a blind external fistula, you force the end of the director through the mucous coat of the bowel where it is thinnest, and in blind internal fistulæ, you introduce a probe into the internal orifice of the fistula, and making its extremity project towards the surface of the ischio-rectal fossa, cut down on the end of the probe. In operating on women, cut as little as possible, especially when the sinus is near the perinæum, or you may get incontinence following the operation.

On one side you may divide both sphincters completely, if you take care to make the incision at right angles to the fibres of the muscles.

TREATMENT OF HÆMORRHOIDS BY LIGATURE.

Steps of the Operation.

The patient is placed on the side, and the thighs and knees are well flexed. Dilate the sphincters, and hook the piles down one by one with a vulsellum, and with a pair of strong sharp scissors separate the pile from its connection with the muscular and submucous tissues upon which it rests, leaving it connected to the bowel above by an isthmus of vessels and mucous membrane only. The large vessels of the pile enter from above. An assistant draws out the pile, and you tie it, as high up as possible, with a piece of strong waxed silk ligature; divide the pile below the ligature, and return the stump within the sphincter.

Apply a pad and a T bandage.

MODE OF PLUGGING RECTUM.

To stop hæmorrhage from the rectum pass a stout ligature through a cone-shaped sponge, which you moisten and powder with persulphate of iron. Introduce the sponge about five inches up the rectum, with the apex of the cone upwards, leaving the ligatures hanging out of the anus. Fill the rectum below the sponge with wool powdered with persulphate of iron. Pull on the ligatures, pushing up the wool at the same time, and fasten their ends over a pad. With this plug in the rectum, you are perfectly secure as regards any risk of hæmorrhage. Leave the plug in for a week or more.

For the main points in the descriptions of operations for ligaturing fistulæ, piles, &c., I am indebted to Mr. Allingham's work on the rectum.

REMOVAL OF PILES BY THE CLAMP AND CAUTERY.

Steps of the Operation.

Each pile is drawn down by vulsellum forceps, and held by an assistant. The clamp is applied to its base, and is screwed up. The pile is then cut off, and the cut surface is wiped, and seared with the cautery. Then relax the clamp, making sure that all bleeding has stopped before the stump is returned into the abdomen.

SECTION XV.—OPERATIONS ON THE GENITO- URINARY TRACT.

PERINEAL SECTION. COCK'S OPERATION.

Steps of the Operation.

1. Place the patient in the lithotomy position, taking care that the pelvis and body are in a straight line.
2. With the left index-finger introduced into the rectum carefully define the position of the prostate and its apex. Retain the extremity of the index-finger in contact with the apex of the prostate.
3. Take a broad, sharp-pointed, double-edged knife, which is specially shaped and ground for the purpose, enter it in the median line of the perinæum, and pass it steadily on till you reach the apex of the prostate, when the point can be distinctly felt by the finger in the rectum.
4. Now advance the point of the knife obliquely to the right or left, and you enter the membranous urethra, which is usually much dilated.
5. Withdraw the knife, still retaining the finger in the rectum. Pass a probe-pointed director along the wound, and, guided by the finger in the rectum, pass it into the urethra and bladder.

6. Pass a canula, or catheter, along the groove in the director into the bladder, and tie it in position with tapes.

Perineal section is sometimes performed when an instrument cannot be passed through the stricture, and especially in cases of extravasation of urine. It is a much more difficult operation to perform than Syme's. For the pathology of this condition, I would refer to a paper in the Guy's Hospital Reports, vol. xxviii., "The Pathology of Extravasation of Urine." The structures cut through in this operation are skin, superficial fascia, external sphincter, possibly portions of the accelerator urinæ and transversus perinei, with a little of the deep layer of superficial fascia covering them in. The anal fascia and the levator prostatae may or may not be incised, the prostatic urethra being frequently perforated instead of the membranous urethra. The anterior, usually also the posterior layers of the triangular ligament, and the deep transverse and constrictor urethræ muscles are cut through.

The difficulty sometimes experienced in this operation is due to the deflection of the urethra from the middle line, due to injury or prolonged suppuration about it.

EXTERNAL URETHROTOMY, OR SYME'S OPERATION.

Steps of the Operation.

1. Place the patient in the lithotomy position. Pass a Syme's staff through the stricture till the thick portion of the staff rests upon the stricture. (The upper portion of Syme's staff is large, while the part that passes through the stricture is very narrow, and grooved along its convexity.) Give the staff into the hands of an assistant, who holds it in position.
2. Make a median incision on to the lower extremity of the

large part of the staff (this point is usually called its shoulder), enter the point of the knife in the groove, and, cutting along the groove, lay open the whole length of the strictured portion of the urethra.

4. Introduce a probe-pointed director along the staff into the bladder. Then pass a large-sized catheter through the penile urethra, and guide its extremity along the groove in the director into the bladder.

In making this incision you divide skin, superficial fascia, with branches of the three long scrotal nerves and of the superficial and transverse perineal arteries, the deep layer of superficial fascia, the external sphincter, the accelerator urinæ and the subjacent bulb, possibly the anterior and even the posterior layers of the triangular ligament with the deep transverse and constrictor urethræ muscles and the anal fascia, with a portion of the levator ani. The structures cut through will vary considerably with the seat of the stricture.

NEPHROTOMY, NEPHROLITHOTOMY, AND NEPHRORAPHY.

In *nephrotomy* or *nephrolithotomy* the kidney may be exposed by the same upper oblique incision used in nephrectomy.

In *nephrotomy*, where there is usually a large bulging bag of fluid or pus, it is not necessary to make the incision so near the last rib.

In *nephrolithotomy*, the kidney being exposed, the index finger is passed between its anterior surface and the peritoneum covering it. You can then press the kidney inwards and backwards on to the psoas muscle, and detect the presence of

a stone in its substance. You may also puncture the kidney substance freely with a needle. Should you find a stone, you make a small opening in the cortex over the stone by means of a narrow-bladed knife, and then dilate this opening by tearing through the kidney substance with dressing forceps or the finger. The hæmorrhage that ensues is controlled by temporary pressure. After the removal of the stone the wound in the loin is closed and a drainage tube inserted.

NEPHRORAPHY.

A similar oblique incision is made and the movable kidney exposed. A catgut suture is passed through the capsule of the kidney and the margin of the wound, and by this means this viscus is retained in its position against the abdominal wall. This operation is not applicable to cases of floating kidney which have a complete peritoneal covering and mesentery.

LITHOTOMY.

Steps of the Operation.

1. The patient is supported by assistants in the ordinary lithotomy position, the knees and thighs being well flexed and the latter abducted. The buttock is brought well forward to the edge of the table. The bowels should have been cleared beforehand by a large enema of warm water, so as to diminish the risk of injury to the rectum. It is also well to have a few ounces of urine in the bladder. If necessary, the perinæum should be shaved. Introduce a curved staff with a good broad lateral groove. An assistant holds it firmly so that the handle is perpendicular and strictly in the middle line, and the curve resting

against the lower border of the symphysis. He also draws up the scrotum out of the way.

Define the position of the tuber ischii with the finger.

2. Use a knife with a straight back and a blade about three inches long. Fixing the skin in front of the point of commencement of the incision with the fingers of your left hand, introduce the point of the knife one-third of an inch to the left of the raphé and an inch and a half in front of the anus in the adult, carry the blade downwards and slightly outwards for two and a half to three inches in a direction midway between the tuber ischii and anus, but inclining a little nearer to the latter. The knife should sink into the interval between the bulb and anus on one side and the ramus of the ischium on the outer side, and the incision should also be deeper in front than behind.

The structures you avoid in making this incision are the bulb and artery to the bulb in front, the rectum posteriorly and internally, and the pudic artery where it lies in the sheath of obturator fascia externally.

In making this incision you divide skin, superficial fascia, fibres of the external sphincter, deep layer of superficial fascia, beneath it the accelerator urinæ, the transversus perinei, the anterior and posterior layers of the triangular ligament, and the posterior margin of the deep transversus perinei muscle between these layers. A portion of the levator ani and the anal fascia may also be divided in this incision.

In the superficial fascia branches of the inferior hæmorrhoidal and of the posterior superficial perineal nerves are cut through, and with the former, branches of the corresponding artery and vein.

In or beneath the transversus perinei may be divided

the anterior superficial perineal nerve, and the superficial perineal artery with its transverse perineal branch.

3. Introduce the index finger of the left hand into the wound and feel for the groove in the staff, where it lies in the membranous urethra just in front of the apex of the prostate. Having found it, introduce the knife into the wound, and get its point into the groove. Now hold the knife so that it makes an acute angle with the horizontal, push the blade on into the bladder. The depth of the incision into the prostate depends on the angle which the knife makes with the horizontal. In making this incision you divide a further portion of the deep transversus perinei, the posterior part of the constrictor urethræ, more of the posterior layer of the triangular ligament, the prostate with a portion of its capsule.
4. Withdraw the knife and introduce the left index finger along the staff, through the prostate, into the bladder.
5. The staff is withdrawn by the assistant. Introduce the blades of a pair of long straight forceps along the palmar surface of the finger till they are within the bladder.
6. Open the blades, and as the urine flows out, close them, when the stone will be found between them.

You may now experience considerable difficulty in removing the stone, but do it slowly, giving the blades a slight lateral motion as you apply gentle traction. By this means you will probably succeed in dilating sufficiently the opening in the prostate.

Should the stone not be caught at once by the blades, it should be searched for by using the forceps as a sound, and when it is felt, it should be got between the blades by a little careful manipulation.

After removing the stone, the bladder should be examined with a small sound, to see if a second is present.

(In describing this operation I have endeavoured to follow, as closely as possible, the directions given by Sir Henry Thompson.)

In Aston Key's operation the straight staff is held by an assistant with the handle inclined a little towards the operator. The same external incision is made as in the last operation, the point of the knife (whose back is not straight, but slightly rounded at the extremity) is made to enter the median groove. You then take the director in your left hand, still keeping the point in the groove, and lower it till the sound makes an angle with the horizon of about 30° . With a simultaneous movement of both hands the groove in the director and the edge of the knife are turned obliquely towards the patient's left side. Now carry the knife slowly along the groove.

You then proceed as in the last operation.

EXCISION OF VEINS IN VARICOCELE.

Steps of the Operation.

1. The scrotum and groin having been previously shaved and the skin thoroughly cleansed, make an incision about an inch and a half or two inches long over the varicose veins, commencing above at a point about half an inch below the external ring. You divide in this incision skin, dartos, branches of the ilio-inguinal nerve and of the superficial external pudic arteries.
2. Cut through intercolumnar fascia, cremaster muscle with small branches of the cremasteric branch of the deep epigastric artery and of the genital branch of the genito-crural nerve, and transversalis fascia enclosing the structures forming the cord.
3. You now see the bulging spermatic veins lying with the

other structures forming the cord in loose areolar tissue, which is continuous above with subperitoneal fat. Taking care to disturb as little as possible the areolar tissue and vessels immediately about the vas deferens, separate the varicose veins from it, and pass a double gut ligature around them at the upper extremity of the wound, and again at the lower extremity, removing the intervening two inches of varicocele.

4. Cut the gut ligatures short, and bring the scrotal margins into exact apposition.

This operation was devised by Mr. Howse, and described by him in a paper in the *Guy's Hospital Reports*, 1877, vol. xiii., p. 468.

SECTION XVI.—OPERATIONS ON THE BRAIN AND NERVES.

TO EXPOSE ANY OF THE MOTOR AREAS OF THE BRAIN.

Steps of the Operation.

1. The scalp should be shaved a day or two previous to the operation, and thoroughly cleansed by strong antiseptic lotions.

Define the position of the fissure of Rolando. This has been already described in the operation for ligature of the anterior branch of the middle meningeal artery, to which description I would refer the reader. A line parallel to this fissure, and situated about an inch and a half in front of it, will serve as the anterior boundary of the ascending frontal convolution, the posterior portion of the transverse frontal convolutions which form the motor areas in front of the fissure of Rolando, and one parallel to it, and situated an inch and a half behind the fissure of Rolando, will form the posterior boundary of the ascending parietal convolution and of the portions of the superior and inferior parietal lobes which form motor areas behind the fissure of Rolando. I would advise the reader to make himself very familiar with

the relative position of the fissures, bones, and sutures in Fig.

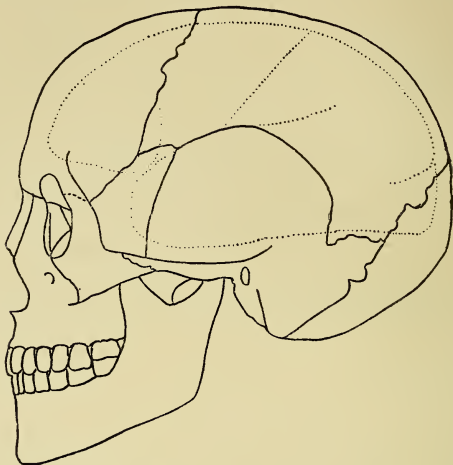


Fig. 60 (*after Thane*) represents a diagram of the skull and shows the relations borne by the principal fissures of the brain to the sutures in the skull. The Fissure of Rolando is indicated by the dotted line which runs behind the coronal suture. Its upper part is distant two inches from the upper part of the suture, and its lower part one inch from the lower part of the suture.

The Parieto-occipital fissure is seen as a dotted line just above the lambdoid suture.

The Sylvian fissure is also seen, its horizontal limb anteriorly corresponding to the anterior portion of the squamo-parietal suture and posteriorly ending beneath the parietal eminence.

Since the longitudinal surface measurement of the frontal bone from the root of the nose to the coronal suture varies but slightly in skulls of different size, being about five inches in subjects with large heads, it will be found that the fissure of Rolando, and consequently the ascending frontal and parietal convolutions, are separated from the coronal suture by a greater interval than that already given as the average distance. The parieto-occipital fissure lies just above the lambdoid suture.

60, and with Fig. 61, in which are shown the several areas.

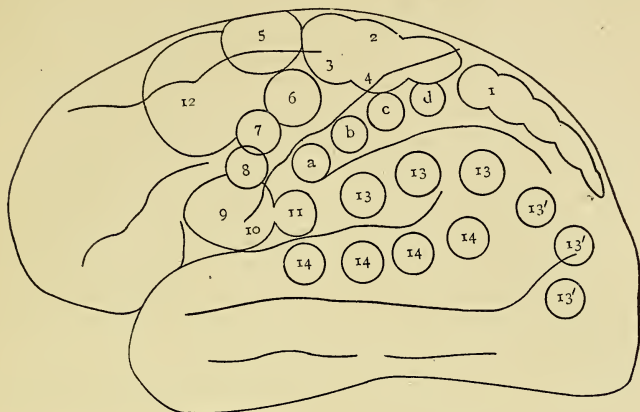


Fig. 61 is a diagram indicating the centres in the cortex of the cerebrum.
(After Ferrier.)

- (1.) Advance of the opposite leg, as in walking.
 - (2) (3) (4.) Complex movements of the opposite leg and arm, as in swimming.
 - (a) (b) (c) (d.) Individual and combined movements of the fingers and wrist of the opposite hand. Prehensile movements.
 - (5.) Extension forward of the opposite arm and hand.
 - (6.) Supination and flexion of opposite forearm.
 - (7.) Retraction and elevation of the opposite angle of the mouth by means of the zygomatic muscles.
 - (8.) Elevation of the alæ and upper lip with depression of the lower lip on the opposite side.
 - (9) (10.) Opening of the mouth with (9) protrusion and (10) retraction of the tongue; region of aphasia, bilateral action.
 - (11.) Retraction of the opposite angle of the mouth, the head turned slightly to one side.
 - (12.) The eyes open widely, the pupils dilate, and the head and eyes turn towards the opposite side.
 - (13) (13'.) The eyes move towards the opposite side with an upward (13) or downward (13') direction. The pupils generally contracted. The centre of vision.
 - (14.) Pricking of the opposite ear, the head and eyes turn to the opposite side, the pupils dilate largely. Centre of hearing.
- The centres of taste and smell are situated in the extremity of the temporo-sphenoidal lobe, and that of touch in the gyrus uncinatus and hippocampus major.

2. Having satisfied yourself as to the position of the area, make a crucial incision through skin, superficial fascia, aponeurosis of the occipito-frontalis, areolar tissue, and periosteum, in the case of the motor areas dividing branches of the temporal artery and vein and branches of the auriculo-temporal, frontal, and great occipital nerves.
3. Remove a good-sized disc of bone, or if necessary several discs, and expose dura mater. (In this case I will suppose that the tumour affects the cortex alone, and has not involved the dura mater and bone.) In cutting the bone you may divide small diploic veins, and, if the section is made low down, branches of the middle meningeal artery, enclosed in canals or grooves in the bone.
4. Cut through the dura mater and ligature any small meningeal branches that may be divided.
5. Divide the visceral layer of arachnoid now exposed, and you see the pia mater covering the convolutions and dipping into the fissures.
6. The portion of brain may now be removed with the knife, or cautery.
7. Bring the edges of the dura mater and skin together with gut sutures, inserting small drains.

STRETCHING OF, OR EXCISION OF A PORTION OF THE LINGUAL GUSTATORY NERVE.

The best and easiest operation is that devised and performed by Mr. Clement Lucas.

Steps of the Operation.

1. The mouth being kept open by a gag, pass a stout silk

suture through the tip of the tongue to one side of the septum, by means of which you draw the organ out of the mouth, and to the side opposite to that on which you intend to divide the nerve.

2. You now see the lingual gustatory standing out as a firm band beneath the mucous membrane, and passing forwards and inwards from the point of origin of the superior constrictor from the jaw to the side of the tongue. Pass a sharp-pointed hook under the nerve so as to fix it.
3. Divide the mucous membrane over the nerve for about half an inch, so that you can see it readily, and then pass an aneurism needle beneath the nerve, and withdraw the sharp hook. The nerve may now be easily stretched, or a portion of it may be removed.

MOORE'S METHOD OF DIVIDING THE LINGUAL NERVE.

Steps of the Operation.

1. A gag is fastened in the mouth and the tongue is pulled upwards, forwards, and to the opposite side.
2. Make an incision with a curved bistoury in a line from the last molar tooth to the angle of the jaw, dividing mucous membrane, beneath it a few fibres of the superior constrictor, and the anterior margin of the internal pterygoid, with twigs of the tonsillar artery. Should the nerve not have been divided by this incision, it can be felt by the finger beneath the margin of the alveolus, where it can be divided with the small artery accompanying it. An incision down to the bone in the line given, and about three-quarters of an inch long, must divide the nerve.

OPERATION FOR STRETCHING GREAT SCIATIC NERVE.

Steps of the Operation.

1. Define the lower border of the gluteus maximus, and the tendons of the biceps, semitendinosus, and semimembranosus.

Make a vertical incision about three and a half inches long, along the outer border of these tendons, dividing skin and superficial fascia, containing branches of the small sciatic nerve.

2. Cut through deep fascia, dividing further branches of the small sciatic nerve, but if possible avoiding its main trunk.
3. Raise the outer margin of the biceps and you feel the great sciatic nerve, lying just beneath it, and on exposing the nerve you may see the comes nervi ischiadici with it. Branches of the sciatic and perforating arteries will be divided in doing this.
4. As much traction can now be made on the nerve as is thought advisable. Some surgeons apply enough force to it to raise the limb from the table. This amount may perhaps be a little excessive.

SECTION XVII.—OPERATIONS ON THE EYE.

SCLEROTOMY.

Steps of the Operation.

1. A pair of stop retractors are introduced between the eyelids. The pupil has been previously contracted by the use of eserine. Fix the eyeball with forceps or with the fixation hook. Enter the point of a Graefe's knife in the sclerotic just outside the corneal margin, with its edge directed upwards, about the level of the junction of the middle with the upper third of the iris.
2. Pass the blade of the knife across the front of the iris, causing it to emerge at a point exactly opposite to that at which it entered.
3. Cut upwards with a slight sawing movement, carefully avoiding any displacement of the iris. Continue this incision till the length of each lateral incision equals that of the intervening undivided cornea.

Some operators, as Mr. Bader, continue this section still higher, leaving only a bridge of conjunctiva and subconjunctival tissue. This operation leaves a bulging mass beneath the upper lid.

Should any portion of the iris prolapse during the performance of this operation it should be excised.

OPERATION OF IRIDECTOMY.

Steps of the Operation.

1. Introduce and fix a stop speculum. Fix the globe of the eye as in cataract operations by a fixation hook (see operation for extraction of hard cataract). Enter the point of an angular iridectomy knife in the outer margin of the cornea, if you only desire to remove the pupillary margin of the iris, as for visual purposes, but in the anterior portion of the sclerotic if a larger portion is to be removed, as in iridectomy for glaucoma.

As soon as the point of the knife enters the anterior chamber, direct the handle so that the blade passes on parallel to the anterior surface of the iris. Remove the knife when you consider you have made a sufficiently large incision.

2. An assistant now holds the eye in position with the fixation hook. Pass the closed blades of a pair of Liebreich's forceps into the anterior chamber, and allowing them to rest on the front of the iris, open the blades, grasping the iris which passes between them, and then close them. The margin and anterior surface of the iris will be caught between their edges.
3. Withdraw the forceps with this portion of the iris and cut it off with scissors. Replace in the anterior chamber by means of a curette any portion of the iris that may be left between the edges of the wound.

When you perform iridectomy for the purpose of vision you do so at the lower or lower and inner portion of the iris, but for glaucoma it is better to remove the upper portion of the iris, as the upper lid then helps to hide the deformity.

EXTRACTION OF LENS FOR HARD CATARACT.

Steps of the Operation.

1. Stand behind the patient. Introduce the blades of a stop speculum between the eyelids. By means of a double hook or a pair of fine forceps fix the eye by getting a firm hold of the conjunctiva and subconjunctival tissue near the margin of the cornea opposite to that at which you intend to enter the knife, and below the level of its centre.
2. Enter the point of a Graefe's knife with its edge upwards at the level of the junction of the upper with the middle third of the cornea through or behind its outer margin, and direct the point of the knife obliquely forward and inward till it enters the anterior chamber of the eye. Pass the knife across the front of the iris and cause its point to emerge at a point opposite to the point of entry.
3. By a series of slight sawing movements cut upwards till the corneal margin is reached.
4. Perform iridectomy at the upper and inner portion of the iris.

This is sometimes performed some weeks previous to the operation.

5. Again fixing the eye, being very careful to avoid any pressure on the globe of the eye, either by means of the stop speculum or by the forceps, introduce the pricker between the edges of the wound with its surface flat. Rotate the instrument so that its point is directed backwards, and carefully draw it across the lens capsule in different directions, so as to allow plenty of room for the subsequent escape of the lens.
6. Carefully press with a curette upon the sclerotic below the

cornea, directing the upper margin of the lens through the incision in the cornea, and finally causing it to escape completely.

Any remains of the lens matter may also be forced out by the same gentle pressure.

In making the incision the knife passes through conjunctiva, a scanty layer of subconjunctival tissue, the sclerotic and cornea, through or near the canal of Schlemm, a portion of the ciliary muscle, the ligamentum pectinatum iridis, the spaces of Fontana, and the layer of cells continuous with Descemet's membrane.

A number of nerves to the cornea are also divided.

NEEDLE OPERATION FOR CATARACT.

Steps of the Operation.

1. The pupil has been fully dilated with atropine.
Introduce a stop speculum between the lids.
2. Fix the eyeball, as in the preceding operation, and pass a cataract needle through the cornea, directing its point towards the centre of the pupil. The needle should puncture the cornea about three millimeters from its margin.
3. With the point of the needle, tear through the capsule, and break up by means of it the anterior portion of the lens. In doing so, you must be careful to avoid injuring the posterior portion of the lens capsule. Remove the needle. This operation is repeated after an interval of some months.

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